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THE SIZE OF OCEAN WAVES.—IV.

(Concluding article.)

By VAUGHAN CORNISH, D.SC.(VICT.), F.G.S., F.C.S., F.R.G.S.,
Associate of the Owens College.

THE diagram Fig. 1 is composed of two parts. In the upper we have a simple wave of length 300 feet and height 15 feet, and a simple wave of length 550 feet and height 15 feet, which are combined in the third line, giving a slightly irregular wave surface of which the average amplitude for the portion shown is about 16 feet, and the average distance from ridge to ridge is 300 feet.

Shorter waves, however, flatten out more quickly than longer ones, so that after the wind has subsided the shorter will cease to be the more conspicuous wave, and the sea will present the appearance shown in the fifth line, an irregular swell with an apparent wave length averaging about 500 feet for the portion shown. For the purpose of this illustration I assume that the longer swell has not yet travelled completely beyond the shorter, as, of course, it will when sufficient time has elapsed.

Fig. 2 is a further illustration of the conditions which determine the apparent dominance of one wave, which, I think, greatly influence the record of average observed length and height.

In this diagram, which is drawn rather roughly, but not too roughly for the purpose in hand, the shorter wave, 150 feet long and 7½ feet high, is plainly visible on the third line throughout most of the distance, but is as plainly subordinate to a longer wave. The wave shown in line 2 is 400 feet long and 20 feet high, it is not only longer than the wave in line 1 but is equally steep, and, therefore, so far dominates the shorter wave that an observer on board ship, who must concentrate his attention if he is to get results at all, measures only the crests A, B, C, D, the average interval between which is 400 feet. The lower three lines of the figure show the combination of two same waves when of equal amplitude. The apparent wave length is now 150 feet.

For the advancement by observation of our knowledge of ocean waves it is desirable that measurements of individual heights and lengths should in future be recorded, and the analysis into constituent waves attempted. The want of a fixed datum line will probably render such analysis imperfect, and the absence of fixed relation between the height and length of the components is a difficulty; nevertheless an approximate analysis could be made, and this would be a decided advance on the present condition of affairs.

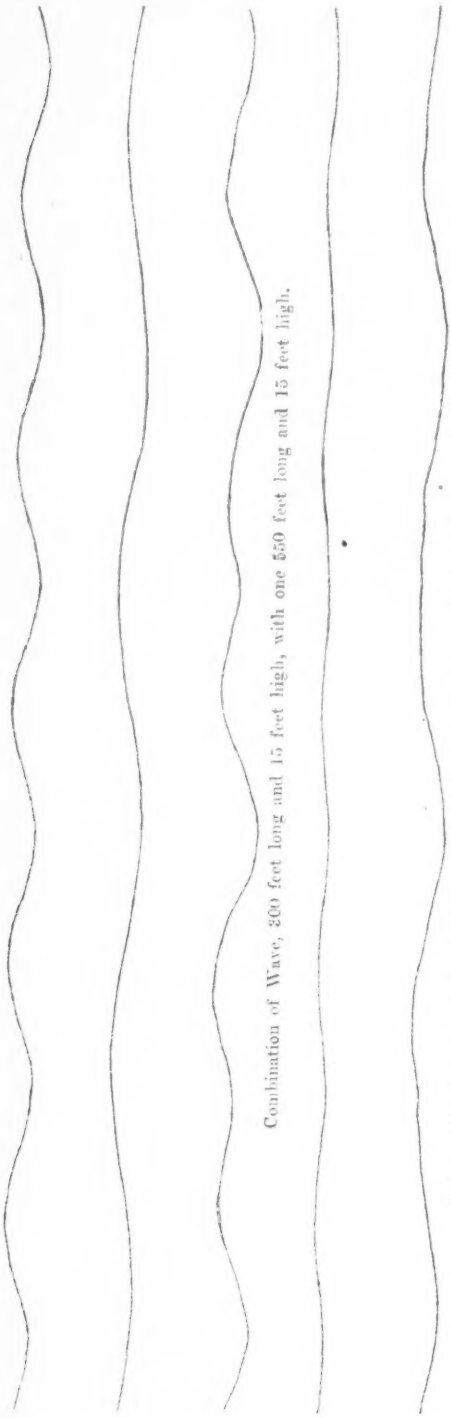
We have here to deal with the measurements at present available; these record the average size of the most conspicuous ridges seen from on board ship (reckoning amplitude as the vertical height from the trough to the next succeeding crest without reference to any datum line), and the average does not seem to differ much from the size of the longest of the steep waves running at the time, which I propose to call the dominant wave. It has been the custom of observers as far as possible only to take measurements when the waves were fairly regular, and to avoid the very common condition indicated in Fig. 3, where the sea is agitated by short groups of high waves with long "smooths" intervening.

Let us now proceed to enquire what light the published observations throw upon the relation of the observed size of the waves to the strength of the wind, the distance through which it acts, and the size of the sheet of water. Tables given in the previous articles show the size of the waves in relation to the strength of the wind, the size of the waves being taken when the sea has attained its maximum roughness. In Paris' table the lengths of the waves are given. From those of Desbois and Wilson-Barker we can calculate the wave length roughly by multiplying the height by about 18. For small waves the number may be 15, for large waves 20. From the length of the waves the velocity is simply calculated by the *formula*:—

$$\underset{\text{(in feet per second)}}{\text{Speed of Wave}} = 2\tfrac{1}{4} \times \underset{\text{(in feet)}}{\text{square root of length.}}$$

This formula, derived from the theory of regular trochoidal waves, has been found to apply to the observed waves at sea with sufficient accuracy for our present purpose. We find that the speed of waves (*i.e.*, the dominant form) in a storm at sea is much less than that of the wind. The long oceanic swells met with after a storm have, however, a velocity approaching that of wind in a strong gale; so much may be said without going into details as to the discrepancy between different records of wind velocity, assuming merely that the conventional "numbers" expressing wind force are roughly comparable in the hands of experienced observers, and

that the latest of the table velocities (that given by Captain Wilson-Barker) may be advantageously substituted for the earlier ones.



Combination of Wave, 200 feet long and 15 feet high, with one 550 feet long and 15 feet high.

FIG. 1.—Combination of these Waves when the shorter has subsided to the proportions shown in the fourth line.
Scale:—Horizontal, 1 in. = 200 ft., Vertical, 1 in. = 100 ft.

Taking 28 feet as the average height of the waves in a violent storm in the ocean, and assuming that the average length is then 20 times the average height, which we know to be approximately the case, the wave length would be 560 feet, and the speed of the wave, therefore, 53 feet per second, 36 statute miles per hour. The wind will then be blowing some 60 miles per hour relatively to an observer stationary upon the water, but only 24 miles an hour relatively to the waves. Waves of greater speed in the same storm would be subjected to a lighter wind, and a wave travelling 60 miles an hour would be in still air. It is not difficult to see, therefore, that the most conspicuous waves in the storm, even *en pleine mer*, will not be the very longest which the wind may be supposed capable of directly creating. The growth in height of the longer waves is thus limited by the diminution of the power of the wind to press upon the more swiftly retreating form. The growth in height of shorter waves, on the contrary, is limited by the circumstance that the slowly moving ridge of water, being subject to almost the full force of the gale, gives way if it become high and steep, bursting in a shower of spindrift.

If we look at the waves raised by the wind upon a pond we see that, commencing with wavelets about an inch long close to the windward shore, there is an increase in height and wave length as we recede therefrom. The waves at any point on the pond soon attain the maximum dimensions compatible with their distance from the windward shore, and however long the wind may blow no further increase in their size takes place. The same phenomenon can be well seen on a lake or any such body of water not subjected to the disturbing effect of a swell.

The following Table (IX.) shows the relation between

TABLE IX.

Locality.	Length of Fetch (d) in Miles (geographical).	Observed Height.	$1.5\sqrt{\text{Length or Fetch}}$.	$1.5\sqrt{d + (25 - \sqrt{d})}$.
Scalpaflow	1·0	4·0	1·5	3·0
Firth of Forth	1·3	1·0	1·8	3·2
Granton	2·8	4·0	2·5	3·75
Craig Nure	3·5	2·0	2·9	3·9
Granton	6·0	4·0	3·7	4·6
Lough Foyle	7·5	4·0	4·1	4·96
Clyde	9·0	4·0	4·5	5·25
Colonsay	9·0	5·0	4·5	5·25
Dysart	10·0	4·2	4·9	5·5
Invergordon	11·0	3·5	5·0	5·7
Lough Foyle	11·0	5·0	5·0	5·7
Glen Lace Bay	13·5	5·5	5·6	6·1
Anstruther	24·0	6·5	7·5	7·7
Lake Geneva (by Minaud)	30·0	8·2	8·2	8·37
,, (by Buckie)	31·0	7·0	8·4	8·5
,, ...	38·0	7·0	9·2	9·2
,, ...	38·0	8·0	9·2	9·2
,, ...	40·0	8·0	9·55	9·5
Macduff	44·5	8·0	10·62	9·9
,, ...	45·0	10·0	10·23	10·0
Douglas (St. George's Channel) ...	65·10	10·12	12·0	—
Kingstown	114·0	15·0	16·0	15·25
Sunderland (distance measured from Broken Bank) ...	165·0	15·0	19·3	18·15

the height of waves and the "length of fetch" of the wind according to T. Stevenson. It is taken from the

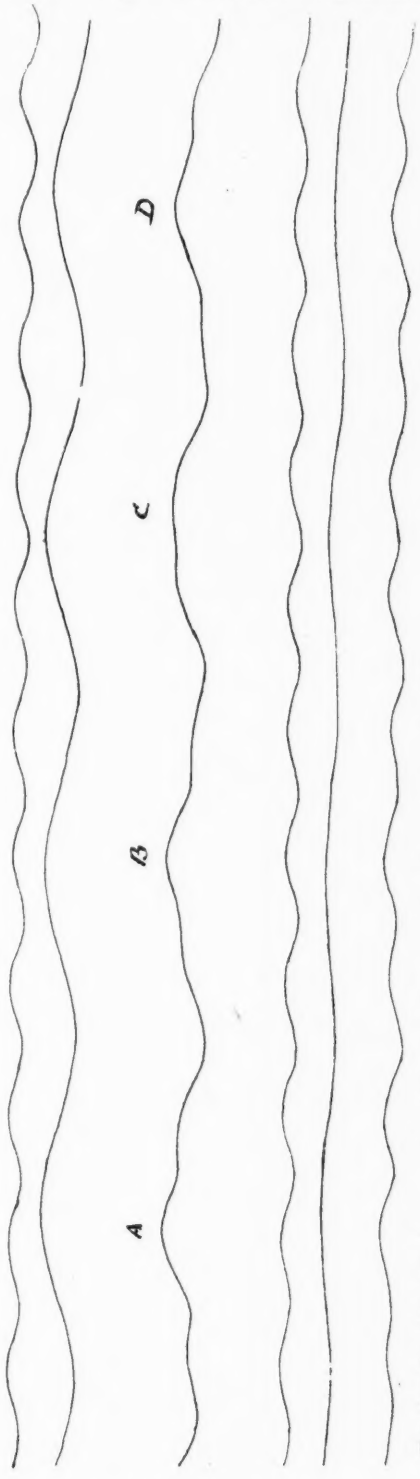


FIG. 2.—The third line shows the Combination of a Wave, 150 feet long and 7½ feet high, with one 400 feet long and 20 feet high; the sixth line shows the combination of the first wave with one 400 feet long and 7½ feet high the first combination is of waves equally steep, the second of waves equally high.
Scale:—Horizontal, 1 in. = 200 ft., Vertical, 1 in. = 100 ft.

article *Harbours*, in the Encyclopædia Britannica, IXth edition. Column 2 gives the distance to the nearest shore in the direction from which the waves come, column 3 the observed height, and columns 4 and 5 the heights calculated from the empirical formulæ which best satisfy the results of observation.

It required many years to compile this table, as it gives the observations of "the effects of heavy gales which could only be made at long intervals of time." The author goes on to say that "the formula $h = 1{\cdot}5\sqrt{d}$ . . . indicates pretty nearly the heights of waves during heavy gales, at least in seas which do not differ greatly in depth from those where the observations were made. This formula is of course inapplicable where the water is not of sufficient depth to allow the waves to be fully formed, or where it becomes so shallow as to reduce their height after they are formed. It must be observed that in short fetches, as in narrow lochs or arms of the sea, waves are raised higher during very violent gales than the formula indicates, though it does not appear that such waves go on progressing in height in the same ratio for any considerable distance."

The observed heights agree well with those calculated from the simpler formula (which makes height vary with the square root of the distance) between the limits of a six and a sixty-five mile stretch of water, between which limits, moreover, there is a fairly numerous and uniformly distributed set of observations. Above that distance there are two values given in the table, viz., for distances of 114 and 165 miles. The former agrees well with the formulæ, the latter does not. Stevenson obtains the "length of fetch" by measuring on the chart the distance to the nearest shore in the direction from which the wind is blowing on the lee shore. When we have to do with greater distances, however, the stretch of water throughout which the wind acts simultaneously in one and the same straight line cannot be thus assumed. If in such cases we restrict the term length of fetch to the space over which the wind is acting throughout in one direction, then, since we have no sure means of ascertaining what that distance is, the notion of "length of fetch" of wind is of little further use to us; if, on the other hand, we continue to note the size of waves in connection with the distance from land in the direction from which the waves are coming, we must not expect to find a continuance of such comparatively simple relations between this distance and the size of wave. Nevertheless it is desirable to take note of this, which I may call the *length of run*, for since ocean waves do not quickly subside, when the wind ceases, the train of waves may be subjected more than once to wind blowing over them in the direction of their movement. Stevenson's values for heights of waves for distances up to 100 miles may be provisionally accepted as applying to those far from the lee shore. At 144 miles the height calculated from his (simpler) formula is 18 feet, and this accords fairly with the experience of waves in the English Channel during easterly gales. But in the western Mediterranean (off the Riviera) the average height of waves in a storm does not appear to exceed 18 to 20 feet,* though the length of run may be taken as 500 miles. Stevenson's formula if stretched to apply to this case gives a height of nearly 37 feet, and is, therefore, no longer applicable to measurement from the windward shore. Whether or not a storm wind blowing in a straight line over 500 miles of water would raise waves averaging 37 feet in height it is nearly certain that such waves would not be normal in the Mediterranean or any other enclosed or nearly enclosed sea. Thus the greatest waves observed by Paris

* *See* Adm. W. H. Smyth. "The Mediterranean."

in the southern part of the China seas, during a strong N.E. gale of several days' duration, were 21 feet in height. This was off Cape Varella, with a length run of about 800 miles. Probably the scale of the cyclonic

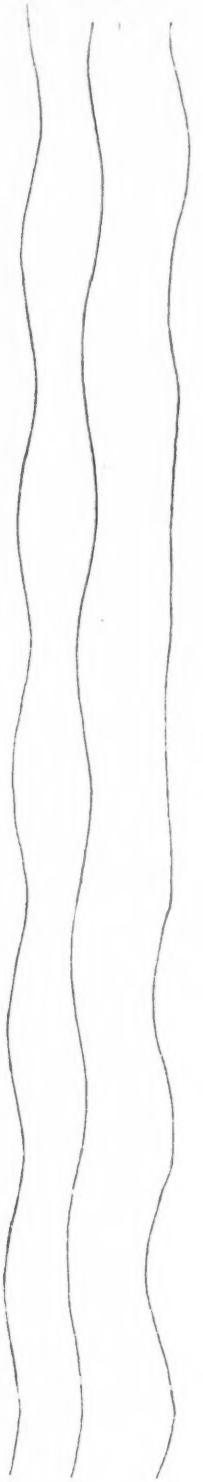


FIG. 3.—Combination of Waves of 300 feet and 350 feet length respectively.

Scale:—Horizontal, 1 in. = 200 ft., Vertical, 1 in. = 100 ft.

disturbances is larger in the great oceanic areas where meteorological conditions are uniform over large areas. This would give a greater real length of fetch to wind of a given direction and a longer period of operation. The waves of violent storms in the oceans may be reckoned to be one-half as high again as those of the seas. I take provisionally 20 feet average and 30 feet occasional single waves for the seas, and 30 feet average with 45 feet occasional single waves for violent storms in the oceans, values which in high southern latitudes are probably somewhat exceeded. This difference I ascribe *partly* to the large scale of the weather in the oceans, with increased length of fetch and increased duration of wind.

Let us consider separately the contributing cause, greater length of run of the waves. It is the shortness of the principal waves first formed by wind which limits their height. The increase in length of the dominant form is a gradual process involving the destructive interference of the shorter waves, and the longer waves must attain a greater amplitude than the shorter before they become conspicuous in the presence of the latter, as I have already explained. Not only does it take a considerable time and length of fetch to make the longer waves the dominant form in a gale, but since they travel more swiftly than the short ones they sooner reach the lee shore. Thus in enclosed seas they soon reach the margin and are put out of action.

In lakes very long waves, such as move with nearly the velocity of the wind in a strong gale, would be too flat to be visible, even after the wind has ceased, except perhaps under a very low angle of illumination, and this flatness would prevent their breaking on the shore, though they might perhaps produce a welling up and down in a period of about 15-18 seconds for the complete double oscillation.

On the other hand, longer waves preserve their form for a much greater time than short ones, as they travel on after the cessation of wind, the rate of flattening being theoretically inversely proportional to the square of the wave length. Thus in the oceans, when a storm has occurred far from a lee shore, the shorter waves die out by subsidence before the longer waves run out, and the sea between the place where the waves were raised and the lee shore is left heaving for days with a long swell. This effect is best seen where the ocean encircles the globe in high southern latitudes. Here the storms come from the westward, the strongest winds are westerly, there is always a swell running from the westward, and there is no eastern shore, the length of run of the waves being practically infinite on the re-entrant surface of the circumpolar water. As each westerly gale rises it blows over the ridges of the heavy swell already running, pressing strongly on the subsiding back, and opposing less the rising front, increasing thus the height of each billow. Thus in the swelling ocean the storm waves of 400 to 600 feet do not have to wait so long before attaining their maximum steepness and becoming the dominant form as if they had to be slowly developed by the tedious process of destructive evolution from the short waves first formed when smooth water is ruffled by the wind.

Marked as is the difference between the storm waves of the Mediterranean, or other seas, and those of the oceans, it is the swell which comes in upon the shore facing the open ocean which we instinctively recognise as the true index of a vaster expanse of water. These swells, as I have pointed out, must have, in deep water, a speed but little inferior to that of the wind during gales.

The development of considerable amplitude in such swells must require a good deal of time, and it is not unreasonable to think of those which come in upon our western shores as having gradually grown (in spite of intervals of partial subsidence) during a run of 3000 miles from the shores of America, experiencing at intervals the force of westerly gales.

THE RELATIVE SPEEDS OF SOME COMMON BIRDS.

By CHARLES A. WITCHELL.

THE flight of a bird is usually so devious that its speed is not easy to determine; and when the journey is directly from one point to another the uncertainty in the mind of an onlooker as to where the flight will end is a further hindrance to accurate observation. A bird in the open, again, flying across the plane of vision and far from a fixed point, requires the preconception of its distance from us before yielding any data of its speed. The difficulty of the subject, indeed, must be urged as the most reasonable excuse for the diversity of rate at which birds have been stated to fly, even by careful observers. The subject of flight is a large one, on which the reader cannot do better than consult the article in Professor Newton's *Dictionary of Birds*. I do not propose to enter into it further than to mention some incidents I have seen in which the relative speeds of some common birds have been tested by the birds themselves, or they have provided man with a means to readily gauge their celerity for a few moments.

The commonest test of such speed is the pigeon-race, but in this the direction of the wind in relation to the birds may be considered the dominant influence. The questions of distance and familiarity with the course also arise. Independently of aid from the wind, 40 miles per hour would seem to be about the full speed for a good pigeon flying a long distance. I have had some experience in this matter, having "timed" for a good many races of the Southern Counties Club years ago. I am speaking, of course, of flight at a moderate elevation, such as pigeons generally affect. With the data available, none would dream of saying that a pigeon could fly at, say, 70 miles per hour against a moderate wind.

With regard to wild birds generally, not having such sure data for guidance the imagination has been allowed fuller play, with the natural consequences.

The swift affords a common illustration. The writer of an article in the *Daily News* thought that the swift could distance any falcon, and attain a speed of 150 miles per hour. I saw an adult male hobby falcon in the flesh, shot on a swift which it had overtaken in fair flight. A friend of Major Hawkins Fisher had seen a similar incident; and he himself bears witness to the wild alarm aroused in some hirundines by the appearance of a hobby from which they sped away, instead of mobbing it as they would have a slower hawk. Also, one of Major Fisher's peregrine falcons, even after the usual tethering of such captives, was able to chase a swift up and down the sky for a minute or more.

One day, travelling by express train through a valley, I noticed that the trees proved the wind to be blowing gently in the direction of our travel; and I also observed that the swifts passing along the valley, even "with" the wind, did not move so fast as the train, which was not exceeding the rate of some 45 miles per hour. The birds seemed to be flying at their usual pace when feeding.

Another bird whose speed seems to be over-estimated is the sparrow-hawk. I have seen it compared to a cannon-ball in celerity; but the suggestion is absurd. A bird which arrives on the scene at full speed has a great advantage over others sedately feeding, so far as the chances of delivering an attack are concerned; and this may be partly the reason why so many of the smaller birds rise on the wing when alarmed by the sight of a hawk. It is as though they considered that, given a fair start, they might disregard the enemy. We, seeing a finch or a starling taken in a moment, often do not weigh the fact that the victim was hardly on the wing, and probably rising, when the bird of prey came like a whirlwind and overwhelmed it. The sparrow-hawk does not more than any other like a long "stern-chase," but prefers to attack with the advantage of a surprise when darting from a tree or around the corner of a wood, or when stooping with splendid speed from a poise several hundred yards above the ground. Even if it discovers its prey when traversing the country at a lower elevation, it has still the power of a fair momentum to take full advantage of the chance of a swooping rush at the prey, which is probably on the ground. Of course, when a rook is watched chasing a sparrow-hawk across the sky, there is nothing to show that the latter is seriously trying to fly at speed. On the contrary, it generally seems in such a case that the hawk is relying mainly on its soaring powers to avoid the attack. And it is remarkable indeed with how little apparent effort the hawk will soar up and up from the rook, which, all the while, is obviously exerting itself frantically. On the other hand, it is generally to be seen that when the birds are flying at a level, the rook has no difficulty in overtaking the hawk, who, after a turn or two, begins to go up, as already stated. The kestrel seems more often to evade its enemies by a turn of speed, though it also takes to the soar readily. Last autumn I saw a fine female kestrel harried by two peewits, which swooped at it alternately very prettily and with surprising persistence. At last the hawk, seemingly tired of "putting out" (as a falconer would say) these active birds, went straight ahead apparently as hard as it could; and then one could see that the peewits were not able to overtake it, though they followed to some distance. The same thing happened with the crow: the latter chased the hawk, but was at last outflown in a sheer straight flight.

Returning to the sparrow-hawk, it is by no means always successful in taking a small bird, even when the chase is over an open field. I have never seen it attempt to take a lark that had anything of a fair start. I never saw a kestrel attempt this prey; and I have seen a skylark go singing past a hovering kestrel (seemingly only a few yards distant) as unconcernedly as though the latter had been a pigeon.

One unsuccessful flight by a sparrow-hawk was very pretty to witness. A fieldfare was attacked far from covert of any kind. The quarry went off at its best, and the hawk raced after it, and overhauled it; but the fieldfare, with a ready turn (an upward turn it seemed) put out the hawk and gained several yards start, to return upon its former course, with the hawk speeding after, as before. Another turn saved the fieldfare, and back it went, for the third time, apparently covering just the same ground; and once more the upward spring

saved it. It shot up still further this time, and the hawk gave up the chase. It should be said that the hawk was a male, and therefore not so very much larger than the fieldfare. Another male sparrow-hawk was not more fortunate with a greenfinch which he chased out of a wood, and hustled greatly, but could not catch; and with a loud twitter the little bird went gaily off.

However, in forming any estimate of the performances of animals, it is well to be able to effect a comparison with some common type; and to gauge the speed of common birds we cannot take a more familiar species than the house-sparrow. The homing pigeon we know can be relied on to attain, under fairly easy conditions, a speed of 60 miles per hour, or considerably more. The sparrow, surely, could never do anything like that! But the fact is that for a short distance the sparrow is well able to keep up with a good homer, and even when flying behind and below it (and therefore in a more disturbed region of the air) to gain enough additional momentum to deliver an attack. We know that the larger and heavier the bird (given a fair wing-spread), the greater its speed; but there is no getting away from this fact of the sparrow overtaking the pigeon. I often saw this at Stroud, the pigeons being excellent homers of pedigree and reputation, and the sparrow an old male that lived near them. I have since seen the same performance enacted elsewhere. In each case it was clear that the pigeon did not relish the attack, but did its utmost to get out of the way. I have several times seen a sparrow chase a starling in the same manner, the latter uttering its cackling alarm-cry. At Stroud it seemed to me that a starling pursued in this way often went at once to perch in a tree, where the smaller bird would not, so far as I know, continue the assault. A few days ago I saw a male chaffinch chase a starling from a Scotch fir, much affected by chaffinches in spring; and in this case, also, the smaller bird seemed to have no difficulty in overtaking the larger.

In February last I witnessed the occurrence of even greater audacity in a sparrow. In spring the sparrow regards the jackdaw with almost as much fear as it views a hawk, in fact, with much more than it sees the kestrel. This is no doubt due, not to adult sparrows being attacked, but to their young being so often removed to supply the larder of the young jackdaws. The daw, ready enough to attack an adult small bird upon occasion, never hesitates to seize a young one if the chance offers. On the occasion in question I saw a sparrow carrying something large over a house. It dropped the burden in the hollow of the roof, and descended there. Along came a jackdaw, soaring about for food, as they do all day at Cheltenham, and down he went suddenly on the roof, returning at once with a nice piece of bread, which he ate on the chimney. He then took wing, and at once the sparrow came after him. Away went the daw, and close behind followed the sparrow, making frequent pecks at him. Stranger still, the jackdaw was clearly seeking to avoid the attack, but vainly. The birds made three good circles; and in the third the daw was swerving like a tin plate thrown from the hand, and close above the garden trees. The sparrow now gave it up, and descended into a roadside tree, while the jackdaw went away. I moved on and passed the sparrow, which was then chirping in that loud and continuous manner which seems to be the nearest approach to singing attained by the species. Possibly he was feeling proud of his victory.

At Charlton, last spring, a sparrow and a swift had decided upon the same site for a nest, for which they were fighting. The hole was under a thatched roof, and so often as the sparrow ensconced himself therein, the swift darted up and dragged him out again. Often the birds fell some distance together before separating. Once they nearly reached the ground. After one of these tussles, the sparrow chased the swift to some distance, and although he could not nearly overtake it, he flew "a very good second" even to that rapid leader, which was certainly frightened and doing its utmost to outpace him.

FOUR-HORNED SHEEP.

By R. LYDEKKER.

OF late years, at any rate, the attention of British breeders of sheep and cattle has been directed to the obliteration rather than to the development of horns; these weapons of offence and defence being not only quite unnecessary to domesticated animals which are never exposed to the attacks of beasts of prey, but often being the cause of serious damage, either from the animals fighting when in the open, or goring one another when crowded together during transit by rail. Among cattle the estimation in which "polled" breeds are held at the present day, and the practical disappearance of the old-fashioned long-horns, are excellent examples of this fashion; while among sheep, if we except the mountain and Dorset breeds, the majority of those bred in this country are hornless.

If, however, fashion and custom had set in the opposite direction, there is little doubt that some extraordinary developments in the form, size, or number of the horns might have been witnessed in both these groups of animals. Length of horn was indeed a feature in the old-fashioned breed of British long-horned cattle, and the massiveness and size of the horns of the humped cattle of Gallaland and Abyssinia, as well as the length frequently attained by the same appendages in the trek-oxen of Cape Colony, bear testimony to the facility with which developments in this direction can be encouraged.

Horn-development among domesticated cattle seems, however, to be restricted to increase in size, with some comparatively slight degree of modification in regard to general form and curvature; and it does not appear that any breed is known in which the horns are permanently characterised by an abnormality in structure.

Very different is the case in sheep, in which the horns seem to lend themselves with great facility to abnormal development in several directions. The typical form of horn is familiar to us in the wild sheep of Europe and Asia as well as in the old classical sculptures of Jupiter Ammon; and this type, although much reduced in size, is fairly well retained in the modern Dorset and merino breeds. In old rams of both breeds there is, however, a tendency to produce a spiral of greater length than ever occurs in wild sheep; and this tendency is perhaps even more noticeable in the mountain breeds of Scotland and Wales. In all the above breeds the original close and incurved horizontal spiral is, however, preserved. But in the so-called Wallachian breed of Eastern Europe the horns take the form of upwardly directed corkscrews, mimicking in fact to a certain degree those of the beautiful African kudu antelope. A single skull in the old Hunterian collection of the Royal College of Surgeons indicates the existence of a closely allied if not identical breed of sheep in Sumatra.

A far more curious modification produced by domestication is, however, displayed by the augmentation in the number of the horns; two, three, four, or even six extra horns being sometimes noticeable. When a pair of such additional horns are developed they usually occupy the upper and fore part of the head, and are of a more slender shape and take a more upright direction than the normal pair, which generally retain their ordinary position and form, although (as in the specimen here depicted) frequently showing a more or less pronounced lack of symmetry. When the Zoological Society possessed a farm at Kingston Hill, in the year 1829, several of these four-horned sheep were kept there; but, although llamas and alpacas, which are just as much domesticated animals, are exhibited at the present day in the Society's menagerie in the Regent's Park, four-horned and other abnormal breeds of sheep are not on show. Those curious in such matters may, however, see a fine four-horned ram from the Isle of Man recently presented to the British Museum by Mr. G. C. Bacon, and now exhibited among the series of domesticated animals in course of formation in the north hall. Here, too, may be seen a number of skulls, with the horns attached, of this remarkable breed: some of them coming from Iceland and others from as far east as China. Five is the maximum number of horns shown in any one specimen in this collection.

Bearing in mind the close affinity existing between sheep and goats, it is not a little remarkable that the additional horns developed in the four-horned breed of the former should approximate to a considerable degree

FIG. 1.—Four-horned Ram, the property of Mr. Cunningham, of South Uist, Hebrides.

both in direction and in curvature to those of the latter. This, however, must not be taken as an indication that the additional pair in the four-horned sheep represent the normal pair of the goats.

Some uncertainty still exists as to whether four-horned sheep belong to one or to several breeds, and also as to the place of origin of such breed or breeds, although they are known to be of very great antiquity. Report has it that one breed at least originally came from Iceland and the Faroe Islands, where they still exist, as they also do in the Orkneys, Shetlands, Hebrides, and the Isle of Man. The four-year-old forming the subject of our illustration is a Hebridean specimen, and was living in South Uist last year. Occasionally, it is said, the little brown sheep of the island of Soa, in the Hebrides, develop four horns, although they are normally two-horned.

Like the Soa breed, European four-horned sheep are of very small size, and dark in colour, the fleece being not unfrequently mottled with patches of brown and white. The wool, too, as in most or all the inferior breeds of sheep, is much mixed with hair, so that it is by no means of a fine quality.

From the islands of north-western Europe four-horned sheep may be traced eastwards across the northern districts of continental Europe and Asia into China, where they appear to be comparatively numerous. Among the nomad Tatars, who are stated to possess considerable flocks of these sheep, the presence of four horns is associated with an enlargement of the base of the tail, owing to the deposition in that region of a large amount of fat. Although such a difference might be produced by crossing Icelandic four-horned sheep with the two-horned fat-tailed breed, it quite possibly indicates an altogether distinct breed. Moreover, Brian Hodgson, a former Anglo-Indian naturalist, in a paper on the tame sheep and goats of the Sub-Himalayas and Tibet, published in Vol. XVI. of the *Journal* of the Asiatic Society of Bengal (1847), states that the Hunia sheep of the Himalaya, which are white with black faces, occasionally develop four or more horns. Again, Darwin, in his "Animals under Domestication," mentions that merino sheep when exported to Chili display the same tendency. It would thus seem probable that there is more than one breed of four-horned sheep.

In most, if not in all, cases the two horns on each side of the head in these sheep are perfectly distinct and separate from one another at the base; but this does not prove that they may not in the first instance have originated by a splitting or division of the young horns of the normal pair.

In this connection it is very noteworthy that the antlers of deer are occasionally bifurcate for a portion or the whole of their length on one side of the head, although there does not seem to be an instance on record where such a feature occurs on both sides. That such duplicated antlers are due to a splitting during early development is rendered perfectly manifest by the head of a fallow-deer figured on page 855 of the *Proceedings* of the Zoological Society for 1896. In this instance it is the right antler which is double throughout its length; but instead of the two divisions of this antler being complete in every detail, the front one corresponds only with the fore half of the normal complete antler, and *vice versâ*. Hence the proof of bifurcation.

On the other hand, in the three-horned red deer shown in Fig. 2 the duplicated antlers of the right side are practically replicas of one another; both being somewhat simpler than the normal left antler. In this case there is no evidence of bifurcation, but the three-horned fallow deer seems sufficient to demonstrate that the origin of the abnormality is the same in both instances. If this be the case, there seems no reason why the additional cranial appendages developed in the four-horned breed of sheep should not have been originally due to fission, although no trace of such original splitting can now be detected.

Splitting seems, indeed, to be a very common mode by which abnormalities are produced. The museum of the Royal College of Surgeons possesses, for instance, the skull of a dog in which both the upper tusks, or canine teeth, are longitudinally split for about half their length. This splitting is clearly due to a partial fission of the crown of the tooth-germ. And it is not improbable that a similar fission, carried to a greater extent, may explain the condition obtaining in the skull

of a fox recently exhibited by the present writer before the Zoological Society. In the case of this animal, which, by the way, was killed during the past winter by the

FIG. 2.—Antlers of French Red Deer, with Duplication on the Right Side. From a specimen in the collection of Viscount Powerscourt.

South Oxfordshire hounds, there are two complete canines on each side of the upper jaw, one behind the other, giving a most remarkable appearance to the head. As already said, the complete duplication of the upper canine may quite possibly be an extreme development of the imperfect fission noticeable in the College of Surgeons' specimen; but, on the other hand, it may be due to the growth of a supplemental germ which exists at the root of most mammalian teeth, but, as a rule, remains dormant throughout life.

To return to our sheep. It has now to be mentioned that the development of two or more additional horns in these animals is by no means the only abnormality which not unfrequently makes its appearance in connection with these appendages. There is, on the contrary, an equally marked tendency to "sport" in the opposite direction, that is to say to the coalescence of the normal pair so as to give rise to what are practically unicorn sheep.

These unicorn sheep have a much more restricted habitat than their many-horned cousins, being apparently confined to a certain portion of the Himalaya or Tibet, although they are not referred to by Brian Hodgson in his paper "On the Tame Sheep and Goats of the Sub-Himalayas and Tibet," already quoted.

Three specimens of the horns of this remarkable breed of sheep are known to be preserved in England, two of them being in the British Museum (to which they were presented by Hodgson), while the third is in the Museum of the Royal College of Surgeons, as the gift of Colonel Finch, in 1830. The latter is described in the Museum Catalogue in the following words:—"The horns have grown parallel to each other, and are firmly united throughout their whole extent, producing the appearance of a single horn, the extremity of which has been sawed off, probably to relieve the animal of the inconvenience of its pressure upon the neck."

Precisely the same description, inclusive of the sawing off of the top of the amalgamated horns, would apply to the two skulls of this breed in the British Museum.

In the case of the many-horned breed of sheep it would seem that the redundancy in horn-development is more probably a disadvantage than a benefit to the animals in which it occurs. And if, as seems to be the case, the amalgamated horn in the "unicorn" sheep tends to run into the neck of the owner so as to necessitate the amputation of the tip, the abnormality is altogether harmful; so that if it occurred in a state of nature it would probably soon disappear.

This amalgamation of the horns in the unicorn sheep presents a curious analogy to the so-called solid-hoofed pigs, which have been known from a very early period. "From the time of Aristotle to the present time," wrote Darwin, "solid-hoofed swine have occasionally been observed in various parts of the world. Although this peculiarity is strongly inherited, it is hardly probable that all the animals with solid hoofs have descended from the same parents; it is more probable that the same peculiarity has reappeared at various times and places." The peculiarity is produced by the welding together of the hoofs of the middle pair into a single large hoof.

Although we may at present be unable to explain the curious variations displayed by different organs among animals under domestication, this is surely no reason why we should neglect to study them at all.

THE STARS NEAR NOVA PERSEI.

FOR the accompanying photographs of Nova Persei and the surrounding stars we are indebted to Mr. A. Stanley Williams, of Brighton. Both were taken with a Grubb 4½ inch portrait lens of about 20 inches equivalent focus, and have been enlarged to a little more than twice the original size. Mr. Williams has kindly furnished the following particulars with the photographs.

"No. I. was taken on February 20th, with an exposure of 47 minutes; No. II. on February 28th, with an exposure of 10 minutes. The latter is not a very good photograph owing to mist and fogging by moonlight, but, notwithstanding this, the apparition of the new star looks rather startling. Unfortunately, owing to cloud and moonlight it was impossible to secure a better one until the star had faded to a great extent. Although dated February 28th, the second photograph may be considered without serious error to show the appearance of the new star at the time of its discovery by Dr. Anderson on the morning of February 22nd (civil date), 28 hours after the first one was taken.

"The original negative of February 20th shows stars down to about 12th magnitude. The fainter stars are necessarily lost in reproduction, though in a successful copy stars down to about 11th magnitude ought to appear.

"The bright little star just above (north of) the new star, and almost exactly in the centre of the photographs, is 9th magnitude. It is BD. + 43° 739."

To this it may be added that the bright star near the edge of the field, on the right, is 30 Persei (magnitude 5.55), and that below it to the left is 32 Persei (magnitude 5.0). The bright star just below the north point of the field is 36 Persei (magnitude 5.55). The magnitudes quoted are on the Oxford scale.

CONSTELLATION STUDIES.

By E. WALTER MAUNDER, F.R.A.S.

VII.—THE SOUTH CIRCUMPOLAR STARS.

THERE is a strange, unforgettable sensation in the first voyage from our high northern latitudes to the southern hemisphere. Night after night the old familiar stars, the constant occupants of our sky at

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NOVA PERSEI AND SURROUNDING STARS.

1900, February 20. 10h. 40m. to 11h. 27m.

1900, February 28. 10h. 59m. to 11h. 9m.

From Photographs by Mr. A. Stanley Williams, taken with a 4½ inch Portrait lens. Nova Persei was not visible when the first photograph was taken, but appears as a bright star near the centre of the second picture.

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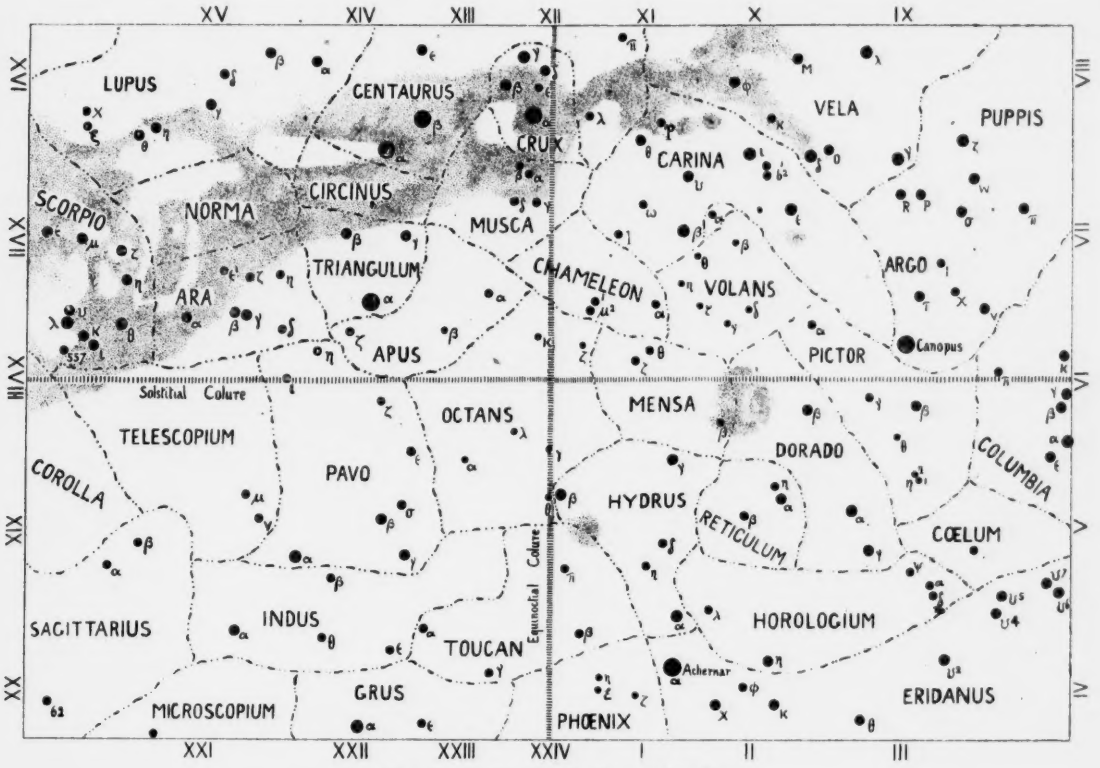
home, sink lower and lower in the north and disappear, whilst new lights rise to shine upon us from the south. But beside the disappearance of old friends and the coming into sight of stranger stars, the known stars that still remain to us adopt most unfamiliar attitudes, and these become more and more perplexing the further south we go. Lordly Orion stands on his head in the exact attitude of a little city Arab, turning a cart-wheel; the long procession of the zodiac, all in turn suffer the same inversion; Pegasus alone, a topsy-turvy constellation with us, pursues his course across the sky with head upraised. Even the moon seems



Star Map No. 7; The South Circumpolar Stars.

altered from the moon we knew in Britain; the mournful face that watched us there is no longer recognisable as such, since we see "his spotty globe" inverted.

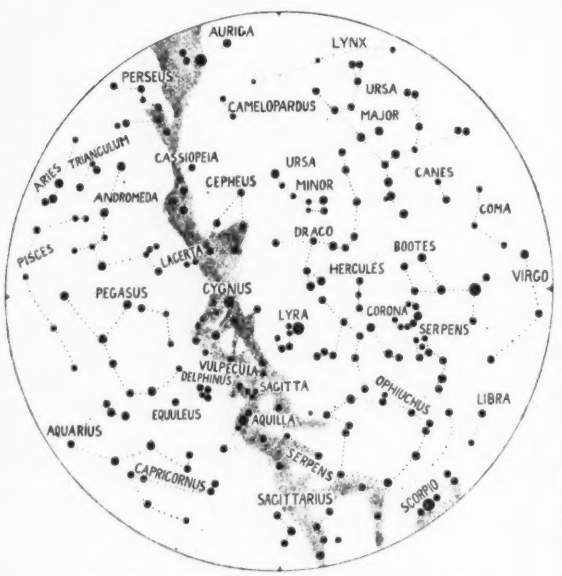
The new regions of the sky opened to us from southern latitudes not only differ in detail from those with which we are familiar, they possess some general characteristics that cannot fail to strike the observer. Starting from Scorpio, here no longer creeping along the horizon as in England, but riding in the very zenith, we find the Milky Way sweeping downwards towards the south-west in masses of the greatest brilliancy and complication. Around its course are gathered the greatest aggregation of brilliant stars to be found anywhere in the sky. The Scorpion is followed by the Wolf and the Centaur, and these by the ship Argo. Between Argo and Centaurus comes the little Southern Cross, a constellation which has perhaps been extravagantly praised, but which yet contains within a very small area three stars above the second magnitude, and six others ranging between that and the fifth. The Centaur claims ten stars brighter than the third magnitude, the Wolf three, Argo fifteen, one of which, Canopus, is inferior only to Sirius. As the Milky Way sweeps through Argo, it enters Canis Major, which, though not a large constellation, contains Sirius and three stars above the second magnitude and three more above the third. This belt of the sky, therefore, from Scorpio to Sirius, is by far the most brilliant in the entire heavens, both from the numbers of brilliant stars clustered within a narrow band and from the brightness of the Milky Way. But beyond this belt we find an altogether different state of things. Round the southern pole there are no star groups to rival the Great Bear, Cassiopeia, the Dragon, or even Cepheus and the Lesser Bear, which surround the northern pole. The new constellations, which were placed round the southern pole by Dircksz, Keyser, and Lacaille, are for the most part entirely destitute of bright stars, or of easily remembered configurations; those actually round the pole being especially poor in this respect. Octans, the constellation in which the southern pole is situated, though of considerable extent, contains but a single star as bright as the fourth magnitude, nearly all its members being fainter than magnitude 5½. The southern pole star, Sigma Octantis, is catalogued as of magnitude 5.8.

The other chief features special to the southern heavens, are the presence of the two Magellanic Clouds, to which there is nothing to correspond in the northern sky. Then close to the Southern Cross, we find the Coal Sack, a great hole in the Milky Way, blacker and much more defined than any corresponding gap in its northern course. There is indeed a "coal sack" in the constellation of the Swan, but the portion of the Galaxy surrounding it is far from being so bright and distinct

as that which hems in this curious island in the great celestial river of light. Lastly the southern heavens generally seem much richer in stars just within the ordinary range of vision than the northern, the barren circumpolar region being almost surrounded by a broad belt, especially rich in the regions of Eridanus and Argo, in which sixth magnitude stars are to be found in unexampled abundance.

For Cape Town and the colonies of Victoria and New Zealand, the Southern Cross is a circumpolar constellation, always above the horizon, and at midnight on March 28th it stands vertically above the south pole, Canopus being then on the same level as the pole and west of it, whilst Alpha Eridani, Achernar, "the end of the river," almost touches the horizon in the south. At the present time of the year, the Cross at midnight is at the same elevation as the south pole but west of it, balancing Achernar at the same distance on the east; whilst Canopus is below the south horizon for South Africa, but just visible for Tasmania and South New Zealand.

These great leader stars enable the general trend of the southern constellations to be easily made out. When the Cross is seen erect, the foot of the Cross is marked by Alpha, the head by Gamma, and the Cross



The Midnight Sky for London, 1901, July 1.

beam by Delta and Beta, Beta being much the brighter of the two. Moving from Delta through Beta, we come at no great distance to the first magnitude star, Beta Centauri, and Alpha Centauri lies but a little further on, almost on the same straight line. Nearly midway between Canopus and Alpha Crucis lies Beta Argus, a star but little below the first magnitude. Not far from Beta is the False Cross, four stars in a trapezium, not quite so bright and a little more widely spread than those of the true Cross. Epsilon Argus forms the foot, Kappa the head, and Delta and Iota the cross-beam.

The many obscure constellations which have been formed in this region may now be pretty easily picked up.

Between Octans, which surrounds the south pole, and the Southern Cross, we have Chamæleon and Musca; close to Beta Argus is Volans, the Flying Fish; Pictor lies by the side of Canopus; the Greater Magellanic Cloud borders on four constellations, Mensa for "Table Mountain," Dorado, Reticulum and Hydrus; the Lesser Cloud lies between Hydrus and Toucan. Five constellations meet round Achernar; Eridanus a primitive constellation; Horologium and Phœnix; and the two just mentioned, Hydrus and Toucan. Passing over to the Southern Cross, the Milky Way between that constellation and the Scorpion sweeps over the feet of the Centaur and six other constellations beside,—two of them primitive. The three constellations immediately below the Scorpion are Lupus, Norma and Ara, of which only Norma, placed in the middle of the Milky Way, is new. Circinus below Norma, and the Southern Triangle below Ara are both new, as also is Apus, which lies between them and Octans. The Southern Triangle is a neat little figure on the edge of the Milky Way, its three principal stars making a diamond with Alpha Centauri. Alpha, the brightest star, and the one furthest from the Centaur, lies midway between Alpha Crucis and Alpha Pavonis, a second magnitude star, the brightest of Pavo, a constellation much brighter than any of the new constellations we have yet noted, and one covering a considerable portion of the zone of small stars to which allusion has already been made. Indus, a fainter constellation, lies between Pavo and Toucan, and completes the band of small asterisms surrounding Octans.

PROF. ADAMS' LECTURES ON THE LUNAR THEORY.*

By P. H. COWELL.

PROBABLY few courses of lectures have enjoyed as great a reputation as those which Professor Sampson, after including them among the collected papers of Professor Adams, has now published in book form. The lectures deal with the most interesting of all problems of applied mathematics, and at the time of their delivery they formed the only adequate attempt to present the subject to a student in a form so that, while a comprehensive view of the whole subject is achieved, numerical labour is as far as possible avoided. As Professor Sampson says, several treatises exist that are intended to form the basis of tables in which completeness is the first object and manner of presentation the secondary. During the period 1860-1889, when Professor Adams was lecturing on the subject, there were in existence elementary theories, of which Professor Sampson truly says that they leave off when the difficulties of the subject begin, that is to say, the various cases of slow convergence have been exposed and not dealt with. To present the same idea in slightly different language: It is conceivable that a computer might repeat the whole of the calculations of a lunar theorist, and verify his numerical accuracy (or detect his errors, as the case may be), and at the end of his work, which would probably take quite ten years, he might not have a clear geometrical conception of what he had been doing. Again, one of the elementary treatises referred to might awaken in a reader some faint glimmering of the

* Lectures on the Lunar Theory, by John Couch Adams, M.A., F.R.S., late Lowndean Professor of Astronomy and Geometry in the University of Cambridge. Edited by R. A. Sampson, M.A., Professor of Mathematics in the University of Durham. (Cambridge: At the University Press. 1900. London: C. J. Clay and Sons.)

nature of the subject, but it would hardly place him in a position to carry on the calculations for himself to the accuracy required for forming tables. Adams to a great extent achieved success in a middle course. He divided and got the mastery of his subject. He left on one side those higher approximations that involve merely labour in computing, and illustrate no principle, but he pushed the lower approximations to a high degree of accuracy, and not merely showed how to obtain, but actually did obtain numerical values for the principal parts of the motions of the node and apse and the co-efficients of the principal inequalities. The great value of his lectures may be illustrated by the fact that when ill-health compelled Adams to cease lecturing shortly before his death, notes of his lectures were borrowed and copied by the younger generation. Professor Sampson was fortunate to be among the last that attended the course, the present writer was among the first to make a copy.

The lectures were last delivered twelve years ago, and were constantly revised during the whole period in which they were delivered. And yet they are already, and have for some time been, to a great extent out of date. The last two chapters of Adams' lectures deal with Dr. Hill's methods. These methods have since been developed by Professor Brown, and made the basis of lectures in Cambridge by Professor G. H. Darwin. The concluding portion of this notice will be to attempt to explain the points of superiority of Hill's method over all that preceded it.

Any co-ordinate of the moon, that is to say, its longitude or its latitude, or its radius vector, or the projection of its radius vector in any direction, may be developed in a series of periodic terms, whose arguments are the sums of any integral positive or negative multiples of four fundamental angles that increase uniformly with the time and at rates that are incommensurable. The immense complexity of the problem may be conceived by imagining four piles of coins of incommensurable value. One pile, we may suppose, consists of sovereigns, and, in addition, "negative" sovereigns, that is to say acknowledgments of debt to the extent of a sovereign; the other piles are to consist of francs, marks, and krönes with corresponding "negative" coins, or acknowledgments of debt. Then for every sum of money that can be made up from these coins, there is a periodic term in the lunar co-ordinate, and if not more than seven to twelve coins are used to make up the sum, then the co-efficient of the corresponding term in the lunar theory is important enough to be calculated. In addition a very great number of these co-efficients are large and correspondingly difficult to calculate, for the same reason that a very slight muscular effort, constantly repeated at regular intervals, will set a swing into violent oscillation, or that a ship that remains moderately steady in some seas will roll violently in others when the interval between one wave and the next happens to be of a certain length.

Now if this illustration has given any idea of the gigantic nature of the task, it will be clear that it will be a great convenience if the theory is such that the terms can be calculated in groups of a small number at a time, first one group and then another group, just as Nature builds up a living organism by "epigenesis," or the adding of one cell to another cell. When this can be done, another stage can be added at any time, should it be considered convenient to do so. When it is not the case, not only is the labour much increased, but it is nearly impossible to extend the work to approximations higher than those at which the original computer left it. This criterion is a condemnation of Delaunay's theory, which, while it is in many ways the most elegant from the mathematician's point of view, has probably proved the most laborious of all in its computations, and has nevertheless not been pushed to such accuracy as might have been desired. But in this respect both the theory adopted by Adams and that propounded by Hill leave nothing to be desired.

Both Adams and Brown (who is working out Hill's theory) divide the terms into groups. Now there is only one way of dividing into groups, and the first group of terms constitutes what is called the variation, which is an inequality in the moon's motion that goes through its period in half a synodic month. Now Adams and all the theorists before Hill start by pointing out, that owing to its immense distance the sun's influence is very slight, and if it could be neglected altogether the moon's orbit would be an ellipse. Then it is found that although the sun's influence is slight, yet in some respects it is cumulative and not periodic, and hence we have a rotating ellipse introduced to our notice which, doubtless, is a very convenient geometrical representation of the moon's path, but it is hardly a good "intermediate orbit" or first approximation for a dynamical calculation, since it does not represent an orbit that would result from an approximation to the actual forces that govern the path of the moon. Now Hill takes the first terms that are calculated—the variation—and interprets them dynamically. These terms and these terms only represent a possible path for the moon that could correspond to the actual case of Nature, with one modification: the sun must be supposed to be at infinite distance, while retaining influence enough upon the earth-moon system to maintain the length of the year at its present value. The next group of terms to be selected for calculation (for although the grouping is determinate, there is a little choice as to the order in which the groups are to be taken) may modify the orbit (by adding what are known as the parallactic inequality, because it only exists in consequence of the sun's parallax not being zero, and the annual equation due to the ellipticity of the earth's orbit round the sun) into an orbit that the moon might pursue, only it happens not to do so. And then the rest of the work consists in this only: the moon is considered to oscillate in two ways about the above-mentioned orbit that it might pursue: in the first place it does not remain in the plane of the ecliptic but oscillates from side to side of it; in the second place it keeps crossing and recrossing the orbit it might pursue. The size of these oscillations must be determined by observation, for, as has been pointed out, they need not exist at all, and their size is subject to no conditions, and might have been anything including their actual values or zero. Moreover, the periods of these oscillations must be determined by calculation, and the lunar theory is then complete.

Calculation shows that the periods of these oscillations are neither of them exactly a month; and, therefore, to confine our attention to the oscillation across the plane of the ecliptic, the node or point of crossing is not the same in each revolution, or, in other words, the node revolves. This is not contrary to expectation; the surprising thing would have been if the period of oscillation had turned out to be exactly a month; and it leads to no inconvenience, such as in the older theories, when it compelled the introduction of rotating ellipses with no dynamical interpretation.

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We conclude with another example of the advantage of treating the eccentricity and inclination as oscillations. It is well known that as long as the arc of vibration of a pendulum is very small, the period of its oscillation remains constant, but when the arc of oscillation is increased, the period of its oscillation is altered by terms depending on the square and higher even powers of the arc of vibration. Now this is one of the simplest dynamical problems to work out, just as the lunar theory is one of the most difficult; but the analogy holds exactly: for the principal term in the motion of the moon's node (or apse) is independent of the size of the oscillations—that is to say, the moon's node would still revolve in about nineteen years even if the eccentricity or inclination were double or half what they are; but the smaller terms in the series that give the motions of the apse and node contain squares and higher even powers of the amplitudes of the two oscillations.

Letters.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

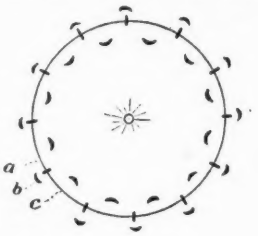
THE ORBIT OF THE MOON.

TO THE EDITORS OF KNOWLEDGE.

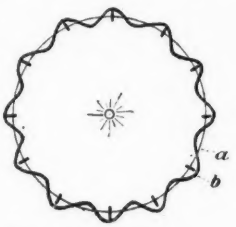
SIRS,—The present communication is intended to fill a gap which exists in all the popular books on astronomy. All those which I have seen contain nothing or little to enable the reader to obtain any idea of the courses of the moon in the heavens. For many years it was a puzzle to me, as it was to others, for I have never yet met with any one, except those who had a professed knowledge of astronomy, who was able to describe in an intelligible manner the course which the moon took in its circuit round the earth and sun.

I was once at the sea-side with a gentleman who had just taken a University degree for which he had to pass an examination in natural science, and we got on the subject of the tides and moon; he declared that he had not the remotest idea how the moon took its annual course. I therefore asked him to stand at a fixed distance from myself to represent the moon as I would the earth, and to hold his stick behind him as I was doing to trace our course on the sand as we walked on. Keeping his distance as if tied to me he was to walk quicker or slower, and thus he would be necessarily revolving around me, whilst at the same time he was moving forward. His movement would not be in circles but in curves. This demonstration being on a plane is of course so far imperfect.

The subject has of late come before me again when some young people during the Christmas holidays attended a lecture on the moon. They were shown the moon's phases in the usual manner by making it perform a circle round the earth; although this explained the varying phases of the moon, they saw for themselves that no such circle could really exist unless the earth were stationary. I made this more intelligible to them, as I have done to others, by drawing the two figures pictured below. I made a circle for the earth's orbit with the sun in the centre, and divided it into twelve monthly parts for simplicity, thirteen being an awkward number to deal with. I then made twelve marks opposite the different divisions to indicate the twelve full moons. This forms the outer circle. My young friends assented to it as correct. They also assented to my making twelve marks between these constituting the inner circle corresponding to the no moon or dark moon. It was now obvious that if these marks were correct the luminary must pass from one to another during the fortnight between them; these, therefore, I joined, and the course of the moon was at once seen. I have heard persons



a.—Earth's orbit.
b.—Outer circle of full moons.
c.—Inner circle of no moons.



a.—Orbit of Earth.
b.—Orbit of Moon made by joining the points.

who have taken some little interest in the heavens declare that this simple drawing was a complete revelation to them as they were so beset with the idea of the circular movement of the moon as portrayed in the books that they could not eradicate it from their minds. As before said this diagram is on a plane, and, therefore, imperfect; but a better demonstration may be made by taking a coil of wire such as is used in electric instruments, bending it into a circle and joining the two ends. When stretched out so as to elongate the coils the spiral may be regarded as showing more correctly the course of the moon.

It must be also remarked that in my diagram there is no attempt at proportion, for it would be impossible to draw on so small a scale a spiral so close to the earth's orbit as to be 400 times less distant from it than the space between the earth and the sun.

Let me finally say I am no astronomer or mathematician, and, therefore, have no pretence to tread on their ground; all I advance for myself is the fact that there being no account of the course of the moon in popular books, the reader being left in ignorance of this subject or often misled, I have found my description and drawing have made it intelligible to them, although of course in a very rough and imperfect way.

SAMUEL WILKS.

P.S.—Whilst inserting my letter the Editors inform me that there are astronomers who have fully discussed the question of the moon's path, and have raised objections against the description which I have given, more especially as from mathematical reasoning this path is everywhere concave to the sun.—S. W.

[The defect of the diagram to which Sir Samuel Wilks' attention was called lies in the simple fact that it is not drawn to scale, and consequently represents the path of the new moon as convex to the sun instead of concave. This concavity should not be difficult to comprehend if it be borne in mind that even at the time of new moon the chief motion is that of revolution round the sun, which it has in common with the earth. The velocity of the moon in its orbit round the earth only amounts to 3000 feet per second, while its average velocity in its motion round the sun is 18.6 miles per second.—EDS.]

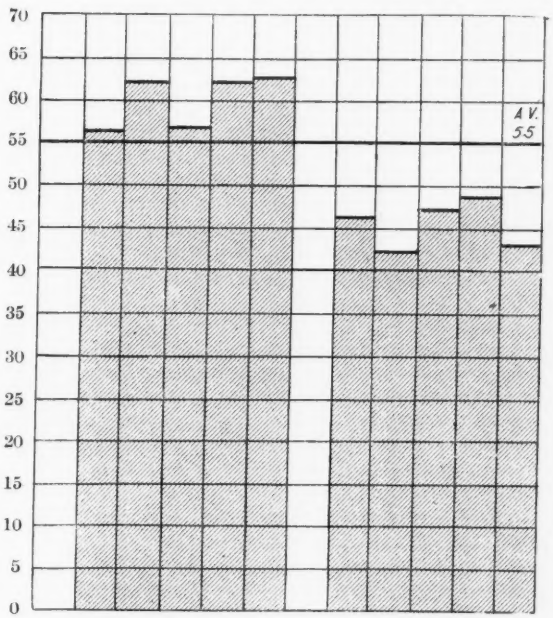
SUNSPOTS AND WINTERS.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—The accompanying rough diagram I would offer for criticism:—*a*, *b*, *c*, *d*, *e*, each shaded column represents the average number of frost days per winter at Greenwich, reckoning from September to May, during

growth of spots (first winter after minimum, to winter ending in maximum year). *a'*, *b'*, *c'*, *d'*, *e'*, the same in three winters following maximum. The one set are all *above* average, the other all *below*.

ALEX. B. MACDOWALL.



a	*b*	*c*	*d*	*e*	*a'*	*b'*	*c'*	*d'*	*e'*
'44	'57	'68	'79	'90	'49	'61	'71	'84	'94
·'48	·'60	·'70	·'83	·'93	·'51	·'63	·'73	·'86	·'96
56·2	61·5	56·3	61·6	62·0	45·7	42·0	47·3	49·0	43·0

DETERMINATION OF NOON.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—We live in a rather isolated district and, as we have no sun-dial, find it difficult to get accurate time. Is there any simple means, by the shadow of a pole or building, by which we could tell exactly when it is noon? Any suggestion you can give us in this matter will be thankfully received. WM. DAVIES.

Concord, Dominica,
British West Indies,
April 24th, 1901.

[The exact determination of time requires the use of instruments, but the approximate time of noon may be ascertained by watching the coincidence of the shadow of a vertical rod with a meridian line drawn on level ground from the foot of the rod. The meridian line is usually formed by drawing a portion of a circle through the end of the shadow some hours before noon, with the foot of the rod as centre, then marking the point on the circle where the tip of the shadow reaches it in the afternoon, and joining the middle of the arc thus formed with the foot of the rod. Several circles should be drawn, and the mean of the positions should be adopted. Noon determined in this manner will be local apparent noon, and correction must be made for the question of time in order to find the local mean solar time which should be shown by a watch. Several suggestions for observing the sun were made by Mr. Maunder in KNOWLEDGE for June, 1900, p. 133.—EDS.]

CLOUDS ON MARS.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—Your correspondent, Mr. E. Lloyd Jones, has, in the April and June issues of this magazine, stated some objections to my previous communication (February). I fear I stated the question rather bluntly when I said, "The atmosphere of Mars is thin, and consequently free from clouds." What I meant at the time of writing was that the clouds on Mars are so rarely visible that they are scarcely worth recording. Mr. Jones will find that this is the view of almost all our modern astronomers. As I stated before, my views on the subject have largely been gained from Mr. Percival Lowell's book on "Mars," and should Mr. Jones desire further information I would refer him to this work. T. R. WARING.

Liverpool.

THE ICE AGE.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—Some years ago you inserted letters of mine on the subject of the Ice Age. I hope the following additional remarks may also find a place in your columns.

The late Prof. Tyndall stated that what was required in order to account for the Ice Age was a better distilling apparatus than at present. But this remark cannot be adopted without qualifications; for with a better distilling apparatus the aqueous vapour might be deposited in the form of rain, not snow. And, in fact, the Ice Age seems to have been succeeded by a Rain Age, for I do not think that the melting of the snows will account for the very large amount of water which seems to have been then deposited on the land. The Ice Age and the Rain Age seem to have resulted from increased distillation under different circumstances.

Air at a high temperature may contain much moisture, but it can hardly be deposited as snow. Air at a very low temperature contains very little moisture, and can hardly produce a snow-cap of any considerable depth. A heavy snow-fall only occurs when the temperature is little below freezing-point, but to produce such a heavy snow-fall two further conditions are requisite: first, that the fall of temperature should be rapid, and secondly that the air should be moist. The latter condition in these regions requires that the wind should be from the W. or S.W.; or at least that the conflict between the wind and one from the opposite quarter should take place over this country before the temperature has sunk too low.

We then require a rapid fall of temperature at a time when the mean temperature is near freezing-point and the air is moist. If the rapid fall takes place before this period of the year there will be a rain-fall not a snow-fall. If later the snow-fall will not be so heavy.

The fall of temperature dependent on the seasons does not vary with the eccentricity of the earth's orbit. The most favourable condition for the formation of a snow-cap at any particular place will, therefore, be that the sun's distance should increase most rapidly at the time of the year when the mean temperature is nearly at freezing-point. I mean, of course, *before* the winter. For when a similar state of things occurs in spring a rapid increase in the distance of the sun would be balanced by a like increase in the length of the day and of the sun's meridian altitude. Suppose then that we take a country in which the mean temperature sinks

to freezing-point about the middle of November, an Ice Age would be most easily formed when the eccentricity of the earth's orbit was at a maximum, and the earth was in aphelion about the middle of August. This would be the period at which the cap would form most rapidly, but it would no doubt continue to increase in mass for some time afterwards, and the most extensive cap might be found to correspond with an aphelion not at midsummer but at the autumnal equinox.

I am not at present considering the competence of the cause assigned by Dr. Croll for the Ice Age in the British Isles. I am only dealing with the date of the aphelion which would be best adapted for the formation of a snow-cap. Even with the present small eccentricity of the earth's orbit the periods of greatest heat and greatest cold are very perceptibly later than the longest and shortest days. With a more eccentric orbit this difference would probably be increased and the mean temperature of England might not fall to freezing-point until a much later date than at present. But whatever this date might be, it is the date at which the sun's distance should be increasing most rapidly in order to produce a lasting snow-cap.

W. H. S. MONCK.

NOTES.

ASTRONOMICAL.—It is reported that the Harvard College Observatory astronomers, who have been at work in Jamaica, have obtained photographic evidence of the existence of snow on the surface of the moon. Details have not yet been received, but it is stated that changes have been detected on many of the mountain peaks, and the simplest supposition is that the variable substance is snow.

Further reports on the eclipse of May 18th state that good photographs of the corona were obtained by both Mr. Newall and Mr. Dyson, and that Mr. Newall also obtained good results with his grating spectroscope and polariscopic camera, but failed to establish the rotation of the corona. The brightest parts of the corona showed marked polarization. Prof. Barnard's long exposure photographs were unfortunately spoiled by clouds. Count de la Baume Pluvinel, who also observed in Sumatra, appears to have been pretty successful, though he did not succeed in demonstrating the rotation of the corona; no Fraunhofer lines were detected in the spectrum of the corona.—A. F.

BOTANICAL.—The report of the Departmental Committee on botanical work and collections at the British Museum and Kew, together with minutes of evidence supplied by a number of eminent British botanists, has been published in the form of two Blue books, which contain matter of very considerable importance to all botanists. The Committee was appointed "to consider the present arrangements under which botanical work is done and collections maintained by the Trustees of the British Museum, and under the First Commissioner of Works at Kew respectively; and to report what changes (if any) in those arrangements are necessary or desirable in order to avoid duplication of work and collections at the two Institutions." The recommendations of the Committee are in favour of the union of the two herbaria, and of their being united at Kew, where suitable accommodation would have to be provided for them. It is considered advisable, however, that the fossil plants and the botanical objects exhibited to the public at the Natural History Museum should be maintained, the latter feature to be extended and developed as much as possible.—S. A. S.

ENTOMOLOGICAL.—The subject of sound-production by insects continues to attract the attention of naturalists. A valuable paper on "The Stridulating Organs of Waterbugs" has been contributed to the current number of the *Journal of the Quekett Microscopical Club* ((2) VIII., pp. 33-46, pls. 3-4) by Mr. G. W. Kirkaldy. He deals principally with the musical performances of the Corixidæ. These little insects make a shrill chirping note, which has been attributed by several previous observers to the action of a "comb" of regularly arranged teeth on the front foot. But Mr. Kirkaldy maintains that this comb is drawn, not as previously supposed, across the edge of the face or beak, but across a special spiny, stridulating area on the opposite front thigh. The arrangement of the teeth of the "comb" varies characteristically in the different species of waterbugs, and Mr. Kirkaldy believes that the elaborated forms of the organ can be derived from the simple row of bristles found on the foot of the tiny Micronetа or Sigara. The fully-developed musical instruments are confined to the male sex. Another important paper on this subject has been lately published by Dr. A. Handlirsch (*Ann. Hofmus. Wien.*, XV., pp. 127-141, pl. 7), who describes also stridulating organs on the thoracic segments of Reduviids and other land-bugs.—G. H. C.

ZOOLOGICAL.—Mr. Lydekker's article on "Mammoth Ivory," which appeared in KNOWLEDGE for July, 1899, has been republished in the *Smithsonian Report* for 1899, now just issued.

In the June issue of the *Proceedings* of the Zoological Society of London, Dr. W. G. Ridewood discusses the structure and origin of the so-called "bonnet" of the southern right whale. This is a large horny excrescence, worn into hollows like a much denuded piece of limestone rock, growing on the head of this particular kind of whale probably in the neighbourhood of the blow-hole. More than one somewhat wild theory has been suggested to account for its presence. One suggestion is that it indicates the descent of whales from rhinoceros-like mammals; another that this species of whale is in the habit of rubbing against rocks in order to free itself from barnacles, and thus produces a kind of corn—although why on the nose alone is not stated! Dr. Ridewood will, however, have nothing to say to these ideas, but considers that the structure is due to the fact of the horny layers which are produced all over the skin are not shed on this particular spot. This is satisfactory so far as it goes, but we still want to know the reason for the local retention of these layers and their growth into a kind of horn.

The brief description of the little known *Equus przevalskii*, as represented by a mounted specimen in the museum at Paris, in the same journal, cannot fail to be interesting to naturalists. Apparently it may now be taken as certain that the animal in question is really a distinct species, and that in some respects at least—notably the presence of "chestnuts" on all

four limbs—it is more nearly related to the horse than to the asses.

The origin and evolution of the Australian marsupials are discussed at some length by Mr. B. A. Bensley in the April number of the *American Naturalist*. In broad contrast to the views of Dr. Wallace, the author is of opinion that marsupials did not effect an entrance into Australia till about the middle of the Tertiary period; their ancestors being probably opossums of the American type. They were then arboreal; but they speedily entered upon a rapid, although short-lived course of evolution, during which leaping terrestrial forms like the kangaroos were developed. The short period of this evolution is at least one factor in the primitive grade of even the most specialized members of the group. In the advance of their molar teeth from a tritubercular to a grinding type, the author traces a curious parallelism between marsupials and placentals. Taking opossums to have been the ancestors of the group, the author considers that Mr. Lydekker may be right in his view that marsupials entered Australia from Asia by way of New Guinea. On the other hand, there is nothing absolutely decisive against their origin being southern.

In the May issue of the same journal Dr. H. S. Jennings shows that the spiral revolution of many small swimming organisms is analogous to the revolution on its own axis of a rifle-bullet, namely, in order to render them capable of maintaining a straight course.

THE degree of Doctor of Science has been conferred upon Mr. Vaughan Cornish by the Victoria University, Manchester, in recognition of his investigations upon waves and kindred phenomena.

Notices of Books.

"ADVANCED EXERCISES IN PRACTICAL PHYSICS." By Prof. Arthur Schuster, PH.D., F.R.S., and C. H. Lees, D.SC. (Cambridge University Press.) 8s. Illustrated.—It is surely an objection for a book which is to be used in a laboratory to be sent out with uncut edges, and we take this opportunity of suggesting to publishers the desirability of cutting the edges of such manuals. The present book is a laboratory guide for students who, having already had some experience in practical physics, are taking up the subject for the examination for the degree of B.Sc. The course includes seventy-five different exercises, and is therefore fairly extensive. It apparently has been difficult for the authors to know exactly how much "theory" to give in this book as an aid to the working of any particular exercise. Sometimes this aid is unnecessarily full, and at other times too slight. The account of errors of observation is good. The drawings are not very plentiful; we may suggest one at least which might be useful in a new edition of the work, viz.: The method of supporting a specific gravity flask in a water bath by rubber bands. Incidentally we may remark that the capacity of this bottle is referred to on page 62 as its volume. The account of methods of accurate weighing is very well done in this section, and the mode of entering complicated notes is made clear by several examples. It is noticeable that no use is made of films in the work on Surface Tension. In the experimental work on linear expansion more detail in the drawing of the apparatus would be useful to teachers, who on reading the book will be sure to want to use the method there given. The apparatus for the measurement of expansion of a gas seems to be very well thought out, and the same remark applies to that used for the latent heat of steam. In the sections under the heading Acoustics, only three experiments are described. The sextant is dealt with at length under Optics, and the great value of the instrument insisted upon—an important point for those engaged in arranging practical courses. In the portion of the work devoted to Electricity a very full account is given of the adjustment of mirror galvanometers. This is sure to prove of great value to the student. Mance's method for internal cell resistance is replaced by Lodge's modification. We confess to liking so much of the contents of this book that regret is felt more has not been included. The standard of accuracy aimed at in the early part of the book seemed to preface an almost cyclopædic course of practical work. It is hence with a certain disappointment that we find platinum thermometry dismissed in a short note. Notwithstanding this, the book will be found of great value by both teachers and students.

"THE SELF-EDUCATOR IN BOTANY." By R. S. Wishart, M.A. Edited by John Adams, M.A., B.SC. (Hodder & Stoughton.) Illustrated. 2s. 6d.—As stated in a general introductory note, the object of the series to which this work is the latest addition, "is indicated by its title, 'The Self-Educator.' It is hoped that by means of these books the most isolated student will be able, without other aid, to ground himself in the various subjects dealt with." The first chapter deals with germination, and is followed by others, treating of root, stem, and leaf. Chapter 6 bears the somewhat fanciful title of "Plant life, manners, and morals," and includes detailed instructions for carrying out experimental investigations into various physiological phenomena—some of which are by no means easy when conducted in a well-appointed laboratory, and under the advice of an experienced investigator, and are, we fear, destined to afford little but disappointment to the isolated, unaided, and untrained student. We are told in a section of this chapter, entitled "Intelligence and Selfishness," that many plants "show a sagacity and foresight not to be despised," as instances of which we have the twining of the stems of convolvulus and hop, and the movements of stamens, the secretion of nectar, and the dehiscence of the pods of some other plants, and we are further informed that "many instances of scheming and contrivance will thrust themselves upon the observer's notice." The author, doubtless, does not intend these expressions to be taken seriously, but it is surely unwise to introduce ideas of this kind, in any form, to the mind of the beginner, by whom the author's light vein may be entirely misunderstood. Further chapters deal with the inflorescence, the flower, and fertilisation and its results. Part II. is concerned with the classification of plants, and although we cannot approve of its arrangement, it will perhaps be found useful by the student who is not yet familiar with the characters of the natural orders. On the last three pages are given hints to the plant-collector, and the titles of a few useful text-books for further study. The author states in his introduction (p. xi.) that "There are many wrong ways of studying botany. . . . But the right method, whatever else it includes, must include the principle of beginning in the field, if possible, and, in any case, with actual plants as wholes, and then proceeding to laboratory work." With this sound principle we fully agree, and a book designed to teach the first principles of botany, particularly if it is to justify the title "self-educator," must be written upon these lines, or fall very far short of what it ought to be. There can be no doubt that the volume before us is not prepared in accordance with the view thus expressed by the author himself. If the author had impressed upon his readers the necessity for constant field-work, and the use of the British or county flora, and had introduced the student to a consideration of living plants before going into the more technical matter which composes the bulk of his work, we think he would have rendered a far greater service to his readers, and come much nearer to achieving his own object. The somewhat diagrammatic figures are badly reproduced, but have the excellence—unusual in text-books of botany—of being original.

"A MANUAL OF ELEMENTARY SCIENCE." "A course of work in Physics, Chemistry, and Astronomy, for Queen's Scholarship Candidates." By R. A. Gregory, F.R.A.S., and A. T. Simmons, B.SC. (Macmillan.) 3s. 6d.—The scope of this book is to a certain extent defined by the sub-title, but it may be stated at once that the use of the term "work" is fully justified by the contents. Whenever possible, work of some sort is made to precede mental exercise, and as the authors remark, "This is the scientific method—to show that the principles, rules, and relationships constituting natural knowledge are records of experience and not matters of opinion." In the sections on Physics and Chemistry, novelties in the way of simple experiments are frequently introduced. While both these sections are admirable, that on Astronomy is of special interest on account of the praiseworthy attempt which is made to extend laboratory methods in the study of this subject. The student is taught how to appeal to the heavenly bodies, and if he has no instruments, he is told how to make them. Particularly to be commended is the simple form of altazimuth described on p. 330, though strangely enough the authors have not made quite clear to the student what excellent opportunities the possession of such an instrument would give him. It is shown how many astronomical phenomena can be elucidated by easy experiments, and the use of squared paper in conjunction with an almanac is introduced with excellent effect. Work is thus provided for cloudy as well as for clear days and evenings, and if there should be an undue proportion of the former, the student may profitably occupy himself in working some of the interesting examples which are given. The book is admirably illustrated, and deserves to find a large circle of students outside the class for which it appears to have been specially prepared.

XUM

"THE MICROSCOPY OF THE MORE COMMONLY OCCURRING STARCHES." By Professor Hugh Galt, M.B., C.M., D.P.H. (Baillière, Tindall & Cox.) Illustrated. 3s. 6d. net. This is an unpretentious little volume which aims at giving the analyst, student, and others who may have to examine materials for adulteration, etc., a basis on which to work. For this purpose a number of photographs have been taken with the aid of a microscope and reproduced in the book with the magnifications in diameters exactly stated. Starch grains are peculiarly unsatisfactory subjects from a photographic standpoint, and the internal markings by which the student is usually directed do not appear conspicuously in the photographs. We are not sure that the aqueous medium that was used for the specimens is the best mountant, and we have often found that the details of such subjects are better displayed in some media than in others. Still the bases for working and deductions are sound, the contours and sizes of the various starches are at once apparent, and these, after all, are the principal features which must guide any comparisons or examinations. We believe that the book will be found an extremely useful one to those interested in the subject and possibly to microscopists generally, for starch grains are easily secured, and there is considerable interest attaching to their examination.

"ROMANCE OF THE HEAVENS." By Prof. A. W. Bickerton. (London: Swan Sonnenschein & Co. 1901.) 5s. If an author's enthusiasm in behalf of a theory would influence opinion, Prof. Bickerton would surely persuade many to accept his theory of cosmical impact, which is really the subject of this volume. Finding astronomy "a chaos of facts" he claims to have converted it into a classified system, and to have explained the genesis of every type of celestial body. The leading idea is not difficult of comprehension. Two dark bodies are supposed to come into grazing collision, with the result that the grazing parts are sheared off to form a third body, the mass of which may be so small that the molecular velocities of its particles will cause its dissipation into space; while the two "wounded stars" become variables or possibly form a double star. In its further development, however, when the author pictures collisions of nebulæ, star clusters, meteoric swarms, and cosmical systems, it becomes much more intricate. We must confess that we find the idea of all this collision in an orderly universe quite as repellant as the author appears to find the commonly accepted views as to the degradation of energy and the coming "universal death"; how he escapes from the latter can hardly be expressed in a few words. Needless to say, the theory is considered to be absolutely demonstrated by the known facts of astronomy, but much of the evidence brought forward is far too slender to be convincing. It is by no means certain, for instance, that the author's interpretation of the spectrum of Nova Aurigæ is justifiable, and the statement that the masses of the two supposed colliding bodies in that case were respectively eight thousand and four thousand times the mass of the sun only makes us doubt other numerical results. In spite of frequent repetitions and its somewhat florid style, those interested in speculative exercises will find the book readable enough, though, unlike the author, they may not regard "probably" and "possibly" as evidence amounting to demonstration.

BOOKS RECEIVED.

The Complete Works of John Keats. Vol. V. Edited by H. Buxton Forman. (Glasgow: Gowans & Gray.) 1s. net.

The Use of Words in Reasoning. By Alfred Sidgwick. (A. and C. Black.) 7s. 6d. net.

The Mediterranean Race. (Contemporary Science Series.) By G. Sergi. (Walter Scott.) Illustrated. 6s.

A Handbook of Pyrography. By Mrs. Maud Maude. (Dawbarn & Ward.) Illustrated. 1s. 6d. net.

Papers on Mechanical and Physical Subjects. By Osborne Reynolds, F.R.S., M.I.C.E., LL.D. Vol. II. 1881–1900. (Clay.) Illustrated. 21s. net.

Select Bibliography of Chemistry, 1492–1897. By Henry Carrington Bolton. Section VIII.—Academic Dissertations. (Smithsonian Institution.)

Fergusson's Surveying Circle and Percentage Tables. By John C. Fergusson, M.I.C.E.

The Commonwealth of Cells. By H. G. F. Spurrell, B.A.(OXON.). (Baillière.) Illustrated. 2s. 6d. net.

Britain over the Sea. Compiled and Edited by Elizabeth Lee. (Murray.) 2s. 6d.

Handbook of Rocks, Minerals and Ores. By W. J. P. Burton, F.G.S. (Laurie.) 1s.

Notes on Manures. By G. C. Broomhead. (Laurie.) 3d.

The North-West Passage by Land. By Viscount Milton, M.P., F.R.G.S., F.G.S., etc., and W. B. Cheadle, M.A., M.D.(CANTAB.), F.R.G.S. (Cassell.) Illustrated. 2s.

The Geological History of the Rivers of East Yorkshire. By F. R. Cowper Reed, M.A., F.G.S. (Clay.) 4s. net.

On the Earthworms collected during the "Skeat Expedition" to the Malay Peninsula, 1899–1900. By Frank E. Beddard, M.A., F.R.S. (From the *Proceedings* of the Zoological Society of London.)

New or Temporary Stars. By J. H. Brown, F.R.A.S. (Brighton: Southern Publishing Co., Ld.)

Morphology of Spermatophytes. By John M. Coulter, PH.D., and Charles J. Chamberlain, PH.D. (New York: D. Appleton & Co.) Illustrated. 7s. 6d.

Biographical, Critical and Miscellaneous Essays and Poetical Works. By Lord Macaulay. (Ward, Lock.) Illustrated. 2s.

All Change. By Wilfred Woollam. (Elliot Stock.) 1s.

Publications of the Smithsonian Institution, March, 1901.

Modern Cremation: Its History and Practice. By Sir H. Thompson, BART., F.R.C.S., M.B.(LOND.). (Smith, Elder.) 2s.

Cerebral Science. By Wallace Wood, M.D. (Baillière.) 3s. 6d. net.

Grasses. (Cambridge Natural Science Manuals.) By H. Marshall Ward, SC.D., F.R.S. (Clay.) 6s.

The Microscopy of the more commonly occurring Starches. By Hugh Galt, M.B., etc. (Baillière.) Illustrated. 3s. 6d. net.

The Law of Universal Balance. By A Shetlander. (Lerwick: T. and J. Manson.)

The Rustle of His Robe. By Margaret Inez Katharine Kern. (New York: F. Tennyson Neely Co.) 8s. 4d.

The Principles of Human Knowledge. By Geo. Berkeley. (Chicago: The Open Court Publishing Co.) 1s. 6d.

Our Country's Shells. (Simpkin, Marshall.) Illustrated. 6s.

Story of Wild Flowers. By G. Henslow. (Newnes.) Illustrated. 1s.

Animal Life. By Jordan and Kellogg. (Henry Kimpton.) Illustrated. 7s. 6d. net.

Plant Studies. By John M. Coulter, A.M., PH.D. (Henry Kimpton.) Illustrated. 7s. 6d. net.

Star Atlas. By Dr. Hermann J. Klein. (S. P. C. K.) Illustrated. 10s.

Astronomischer Jahresbericht. By Walter F. Wislicenus. (Druck and Verlag von Georg Reimes.)

Debrett's Coming Events: Monthly Calendar of Social Fixtures, etc. (Dean & Son.) 6d. net.

Homoculture by Selection. By Henry Smith, M.D.(JENA). (Watts & Co.) 6d.

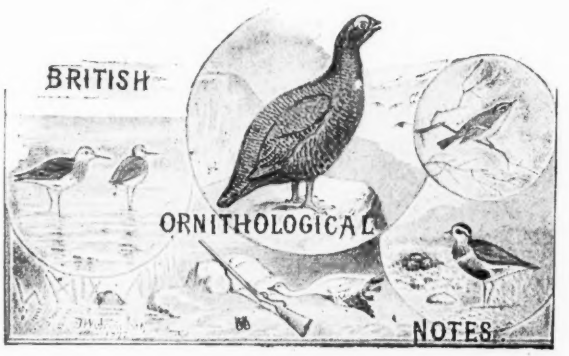
Catalogue of Apparatus, Material and Appliances, etc. (Sanger, Shepherd & Co.)

Flies and the Science of Scavenging. By G. V. Poore, M.D. (Reprint from *Lancet.*)

Catalogue Photographic Apparatus. (Sanders and Crowhurst.)

Ministry of Finance—Ghizeh Zoological Gardens. Report for the Year 1900. By Stanley S. Flower, F.Z.S.

Publications of the Smithsonian Institution—Annual Reports, 1897, 1899 (Two Vols.), and 1900.



Conducted by HARRY F. WITHERBY, F.Z.S., M.B.O.U.

STARLING OR NUTHATCH?—Much has been said lately in praise of the Starling. To the agriculturist the Starling is without doubt a benefactor, owing to the enormous number of grubs it consumes, and its increase in this country within the last few years should prove a blessing to the farmer. By the ornithologist, however, this great increase can hardly be regarded favourably, notwithstanding the interest attaching to the fact itself. The Starling is an amusing bird, but you can have too much of a good thing, and if the Starling continues in his

aggressive career, he will soon drive away other more interesting and attractive birds which stand, I venture to say, nearer to our affections than he does. In the New Forest, for instance, the Starling has increased enormously during the last few years. Everywhere about the woods you will find him and his young screech from all the "likely" holes in the trees. The truth is that, with all his clumsiness, the Starling has a keen eye for a good home, and he calmly appropriates, or fights for if necessary, the best nesting holes. The result is that the Nuthatches and the Great Tits, the former especially, have some difficulty in finding nesting sites. One would think there was a limitless supply of nesting holes where there are so many old trees, but every one who has examined such holes knows that a good many conditions have to be fulfilled before a really dry comfortable place for a nest is formed. In the New Forest the Nuthatches have certainly decreased greatly during the period in which the Starlings have been increasing. Personally I would far rather watch and hear one Nuthatch than a hundred Starlings, but what can be done?—HARRY F. WITHERBY.

Glossy Ibis in County Durham. (*The Naturalist*, May, 1901, p. 149.) Mr. T. H. Nelson records that a Glossy Ibis, an accidental visitor to Great Britain, was shot near Stockton-on-Tees on November 25th last.

An Observational Diary of the Habits—mostly domestic—of the Great-crested Grebe (*Podicipes cristatus*). By Edmund Selous. (*Zoologist*, May, 1901, pp. 161-185.) Mr. Selous has already contributed to the pages of our contemporary two papers, to which we drew attention (referring to the Nightjar and the Stone Curlew), similar to the present one. This article, however, is more literary in style, and is therefore more interesting reading, without any deterioration in scientific value, than the previous contributions, which were somewhat wearisome by reason of their excess of detail. Mr. Selous has made a number of interesting observations, regarding especially the nesting and pairing habits of the Grebes. He comes to the conclusions that the birds pair on the nest itself; that the male, in addition to helping the female in building, constructs a platform of weeds at some distance from the nest whereon to rest; and that the birds usually attack their enemies from under the water. Mr. Selous' theories are less happy than his records of facts.

All contributions to the column, either in the way of notes or photographs, should be forwarded to* HARRY F. WITHERBY, *at 10, St. Germans' Place, Blackheath, Kent.

THE INSECTS OF THE SEA.—IV.

By GEO. H. CARPENTER, B.SC.(LOND.), *Assistant in the Museum of Science and Art, Dublin.*

BEETLES (*continued from page* 116).

ANOTHER well-marked marine genus of Rove-beetles is Diglossa or Diglotta,‖ in which the feelers are relatively long, and the palps of the first maxillæ most remarkably so, while those of the second maxillæ are represented only by long bristles. Two species—*D. mersa*, Haliday (Fig. 7), and *D. sinuaticollis*, Rey, inhabit the British, Irish, French, and Dutch coasts. Elsewhere, Diglotta seems only known on the island of Celebes. In these beetles the wings are reduced, often to very small vestiges. Consequently they do not fly but run actively about in the sunshine over rocks and shingle. *D. sinuaticollis* is said to escape submersion by burrowing in the sand just above high-water mark in company with the Bledii before mentioned. The beetles make little holes about $\frac{1}{2}$ inch deep, and dwell therein singly or in pairs. The larva, described and figured by Haliday, has a very large head, and long legs, which are remarkable in possessing three-segmented feet (Fig. 6).

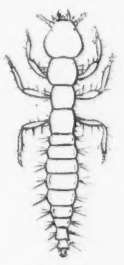


FIG. 6.

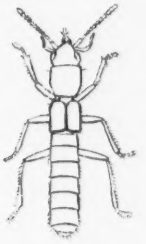


FIG. 7.

FIG. 6.—Grub of *Diglotta mersa*. (After Haliday.) Magnified 20 times.

FIG. 7.—*Diglotta mersa*. Magnified 20 times.

One other genus of marine Rove-beetles must be mentioned—Micralymma. The European species, *M. brevipenne*, Gyll. (Fig. 8), which occurs on the British coasts, and northwards on the Continent from France to Scandinavia, may be recognised by its comparatively short and broad form. The surface of the body is densely pitted and very finely pubescent. As in Diglotta the wings are much reduced. The insects may be found lurking in crevices of the rocks or walking about on the stones and shingles usually below high-water mark. They are believed to hunt and feed upon the spring-tail *Anurida maritima*, which was referred to in a previous article of this series. A good account of the form, transformation and habits of this little beetle was given more than thirty years ago by Laboulbène.¶ He found that,

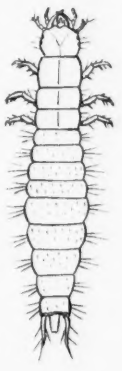


FIG. 9.

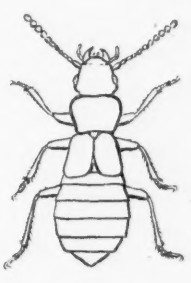


FIG. 8.

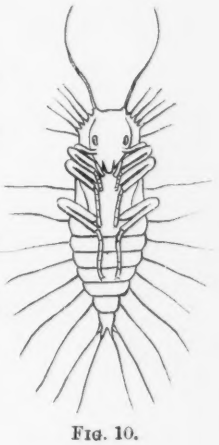


FIG. 10.

FIG. 8.—*Micralymma brevipenne*. Magnified 10 times.

FIG. 9.—Grub. (After Laboulbène.) Magnified 15 times.

FIG. 10.—Pupa. (After Laboulbène.) Magnified 12 times.

even at low water the insects were reluctant to leave their hiding-places, and that they made their way over the rocks rather slowly, hardly lifting the large hind-body from the ground. When taken in the hand they re-

‖ A. H. Haliday. "Notes about Cillenum and a sub-marine Species of Aleocharidæ." *Ent. Mag.*, IV., 1837, pp. 251-3. *Also Nat. Hist. Rev.*, Vol. II., 1856, pl. 3; and Vol. III., 1857, p. 20. G. C. Champion. "Some Remarks on the two Species of Diglossa occurring in Britain." *Ent. Mo. Mag.*, XXXV., 1899, pp. 264 5. B. Tomlin. "Notes on the Habits of *Diglotta sinuaticollis*," *t.c.*, p. 290.

¶ A. Laboulbène. "Sur les Mœurs et l'Anatomie de la Micralymma brevipenne." *Ann. Soc. Ent. France* (3), VI., 1858, pp. 73-110, pls. I.-III.

warded their captor with "une odeur très mauvaise et tres pénétrante."

The grub of Micralymma is more lively than its parent beetle. It is elongate in form, with the legs short, stout, and spiny; the tubular process at the hinder end can be bent downwards to act as a false-foot or pro-leg (Fig. 9). The pupa is a most wonderful creature, with its armature of long bristles that doubtless serve to entangle air-bubbles for breathing (Fig. 10).

As might be expected, the Ground-beetles (Carabidæ)—those active, predaceous, swift-running insects, which lurk commonly under stones and in such places—are well represented by the sea-shore. Space would fail us to enumerate the sand-dwelling Ground-beetles that may be met with above high-water mark. Several kinds of Dyschirius, for instance, small, dark, shining bronzy beetles, with the fore-shins flattened and strengthened to serve for digging, abound on our coasts. They burrow into the sand in pursuit of the Rove-beetles of the genus Bledius mentioned above and ruthlessly devour them.

There is a large group of small Ground-beetles—the Bembidiina—which frequent damp places, and are indeed semi-aquatic in their habits. The most characteristic structural feature of this group, the very short and pointed terminal segment of the second maxillary (labial) palp (Fig. 11, L. p.), is found also in the Haliplidæ, that family of true water-beetles which is most nearly allied to the Carabidæ. The very numerous species of Bembidium are the delight of the specialist, and the despair of the average beetle-collector. Several of them may be found on the sea-shore, but they seem to keep out of the reach of the tides. There is an allied genus, however—Lymnæum—a species of which, *L. nigropiceum*, Marsh, occurs locally on the south coast of England and in the Isle of Wight, lurking under stones and shingle, below as well as above high-water mark. This little beetle inhabits also the French coast and the shores of Dalmatia and the Crimea. The most remarkable discontinuous range of this species is analogous to that of its genus which occurs in Europe, the East Indies, California, and the Kurile Islands near Japan.

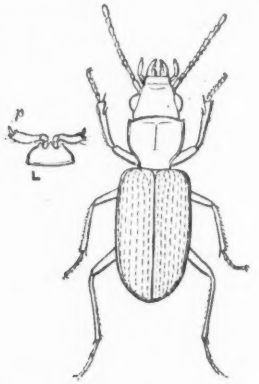


Fig. 11.—*Cillenus lateralis*. Magnified 10 times. L, second maxillæ (labium), magnified 20 times. (*p*, palp.)

Still more specialized for a marine life is *Cillenus lateralis*, Sam. (Fig. 11), the only species of its genus, distinguished from Bembidium by its relatively shorter feelers and parallel-sided elytra, which are of a pale, sandy colour with dark markings, the large head and fore-body being shining bronzy green. Cillenus occurs at many points on the British and Irish coasts, sometimes beneath stones, sometimes on the sand, but almost always below high-water mark. Its continental range extends northwards only to Holland, but southwards as far as Portugal and Morocco. It is remarkable that while British specimens of this beetle are all wingless, those from southern Europe are occasionally winged; evidently the species as a whole has not entirely lost the power of flight. At low water numbers of Cillenus may be found running in the sunshine; when the tide rises they retire under stones, or dig holes between one or two inches deep in the sand. In such shelters they survive in safety their immersion twice every day. A. H. Haliday, in the paper to which reference has already been made, gives a vivid account of the habits of Cillenus as observed by him on the Co. Dublin coast in the year of Queen Victoria's accession. "They prey upon sandhoppers (Talitrus), seizing them by the soft part of the underside, and, in this way, are able to master game many times their own bulk. Sometimes three or four beetles may be found in concert, attacking a sandhopper of the largest size. The tide retiring has scarcely uncovered the sand when these little depredators are abroad from their hiding-places and alert in the chase." The grub of Cillenus has been described by Fairmaire. It has short legs and a very large head with long, formidably toothed mandibles.

Another group of Ground-beetles with marine representatives are the Trechina—a tribe allied to the Bembidiina, but distinguished by the elongate terminal segment of the labial palp (Fig. 13, L. p.). The species of the large genus Trechus live mostly in dark concealed situations, under stones, for example, or in burrows along the banks of streams. One of them, *T. lapidosus*, Dawson, occurs just above high-water mark on the sea-coast and along the shores of tidal rivers. But the small beetles of the allied genus Aepus are perhaps the most characteristically marine members of the whole family, and, indeed, of the entire order of beetles.

Small as these beetles are, 2 mm. (about $\frac{1}{12}$ inch) in length, their aspect when seen with a moderate magnification is striking and not easily forgotten (Fig. 13). The relatively immense head, larger than the forebody shield, and the truncate abdomen, broadest at its hinder end and only partly covered by the wing-cases, give the insect a most characteristic appearance. Both the European species of Aepus occur on the British and Irish coasts. *A. marinus* (Strœm.) has a deep dorsal furrow on the forebody, and rather long parallel-sided wing-cases, while *A. Robinii*, Laboulb., has an indistinct dorsal furrow and shorter wing-cases widened behind. These insects both occur on the French and Spanish coasts, and there is a third species on Madeira, and another far away in Chile. They have not been found north of Denmark, and it is remarkable that they seem to be absent from the newest part of our own coast line—from Yorkshire to Sussex, the region by which our island was in Pleistocene times joined to the European continent. While the range of most of the shore-haunting spring-tails points to an old continental coast-line stretching from our area towards the north, that of Aepus, and, as we have seen, of most of the marine beetles, indicates the former extension of the old land to the south and south-west. Aepus is clearly a very ancient genus, and it is possible that these beetles were amongst the first members of our present fauna to reach our area, belonging as they clearly do, to the south-western (Lusitanian) group, whose restricted distribution shows them to be the oldest animals surviving in our islands.

Several points in the structure of Aepus deserve a passing mention. Wings seem to be quite absent. The widened fore-shin, as in several other ground-beetles (including Cillenus), has a deep bristle-fringed notch towards its far end; this serves as a comb for cleaning the feelers, which can be drawn through the notch so that particles of sand are removed by the bristles. The compound eye of Aepus is composed of a relatively small number of circular facets; the eye in marine insects is frequently thus, instead of being built up of an immense number of hexagonal facets. Behind the facets, according to Prof. Miall, is situated a concave plate with a circular opening; "the form of this plate," he writes, "suggests that it may be employed as a kind of pin-hole camera." Another interesting fact discovered by Prof. Miall and Mr. Hammond, is the presence of a pair of large air-sacs at the hinder end of the abdomen in Aepus; these "are no doubt useful during prolonged submersion." These beetles are provided with long bristly hairs, which, as Audouin** noticed nearly seventy years ago, serve to entangle air-bubbles when the insect is submerged. "If," he wrote, "one transfers the insect directly from the air into sea-water, one notices that each of its hairs holds a little layer of the surface film, which forming at first tiny spheroids soon unite into a little globule which surrounds its body on every side, and which, despite the agitation resulting from the insect running under the water . . . . never escapes. Our insect always carries about a little layer of air, and when it hides beneath a stone, it finds itself at once in the condition of insects living freely in the atmosphere." Coquerel†† made some experiments as to the length of time which Aepus can remain under water. Their habit when the tide rises is to take shelter beneath stones and remain there till the ebb again sets them free. Coquerel found that when immersed under artificial conditions for a very long time "they always finally fell into a state of apparent death. I have kept them thus," he writes, "for eighteen hours under water. I believed them dead, but having placed them in the sun on a sheet of paper, they revived after some minutes and began to run about as before."

FIG. 12.

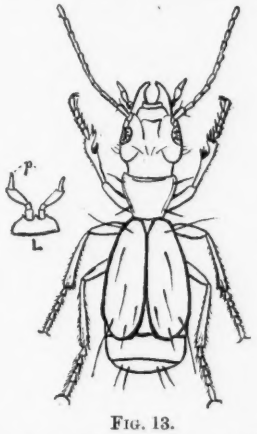


FIG. 13.

FIG. 12.—Grub of *Aepus marinus*. (After Westwood.) Magnified 20 times.

FIG. 13.—*Aepus Robinii*. Magnified 20 times. L, second maxillæ (labium), magnified 40 times. (*p*, palp.)

Like its parent beetle the grub of Aepus has a very large head, armed with sharp, strong mandibles, and is very active in its habits when the tide is out. The hairy covering wherewith it is provided helps to entangle air-bubbles. Both beetles and grubs are believed to prey on small molluscs, such as Rissoa, in whose company they are often found.

There is something fascinating in the study of the life of these small beetles, spending, as they must, the greater part of their time under stones on the sea bottom, waiting for the fall of the tide to allow them a few hours' activity in the air, which is, after all, their true element. The observer on the shore, as he watches the breakers rolling in at the flood, may well give a thought to the tiny insects, safe in their hiding-places far beneath the restless waves, waiting there patiently until the ebb shall release them once again from their watery prison.

** J. V. Audouin. "Observations sur un Insecte Coléoptère qui passe une grande partie de sa vie sous la Mer." *Nouv. Ann. Mus. Hist. Nat.*, III., 1833, pp. 117–127.

†† C. Coquerel. "Note pour servir à l'Histoire de l'Aepus Robinii et description de sa Larve." *Ann. Soc. Ent. France* (2), VIII., 1850, pp. 529–532.

STANDARD SILVER: ITS HISTORY, PROPERTIES AND USES.—III.

By ERNEST A. SMITH, ASSOC. R.S.M., F.C.S.

IT is well known that silver wares, when exposed to ordinary atmospheric influences, soon become disfigured by blotches of tarnish, due to the action of the sulphur in the air, and in consequence require to be repeatedly cleaned to present a bright appearance.

This being one of the drawbacks to silver goods a few remarks on this subject are not without interest, as the surface will become perfectly black in a few months' time if continual cleaning is neglected.

Some interesting directions for the care and cleaning of silver-gilt plate are preserved with the church-plate of Stinsford, in Dorsetshire.* The directions, which are dated June, 1737, are given by Paul Lamerie, the silversmith who made the plate. They run as follows:—"Clean it now and then with only warm water and soap, with a Spunge, and then wash it with clean water, and dry it very well with a soft Linnen Cloth, and keep it in a dry place, for the damp will spoyle it."

The instructions given by the silversmith who made the plate for Carlisle Cathedral in 1679 may be compared with the above extract as they are equally worth attention. "Be carefull," he says, "to wipe it with a clean soft linnen cloath, and if there chance be any staines or spotts that will not easily come off with a little water, the cloath being dipp'd therein, and so rubb the flagons and chalices from the topp to the Bottome, not cross wise, but the Bason and patens are to be rubb'd roundwise, not acrosse, and by noe means use either chalke, sand, or salt." These last words cannot be too strongly emphasised, as much damage is frequently done to silver plate by excessive rubbing and the use of injurious cleaning materials. The simple directions given by Paul Lamerie and his brother silversmith still serve as a good guide for cleaning plate. By the adoption of the following process it is stated† that large stocks of silver articles may be protected against atmospheric influences and will remain as bright as when first new.

* Quoted by Cripps, "Old English Plate," 6th Edit., 1899, p. 15.

† "Jeweller and Metalworker," Vol. XXVI. (1900), p. 102.

XUM

The process consists in coating the wares with a thin solution of collodion varnish, diluted with spirits of wine to a thin fluid. The articles should be slightly warmed, and the varnish applied by means of a soft white bristle brush, and on the evaporation of the spirit a thin transparent film of glossy substance is left behind, which preserves the brightness of the metal, and dispenses with the constant labour otherwise required in keeping the articles fresh and lustrous. As a thorough safeguard against tarnishing it is advisable to paint the articles more than once. The varnish is easily removed by means of warm water.

Articles which have become very much tarnished may be restored by carefully rubbing them over with a clean piece of soft cloth wetted with a dilute solution of potassium cyanide (about 1 oz. to 1 quart of water), and then well rinsing them in clean water when the silver appearance has returned.

Owing to the want of sufficient data it is somewhat difficult to ascertain the total quantity of standard silver prepared annually in the United Kingdom, but an approximation to this quantity may be obtained from data published in the Annual Reports of the Royal Mint.

The following figures, taken from the most recently published Mint report, gives the total quantity of standard silver prepared in the year 1899 for the purposes of coinage and medals, and also the quantity marked at the Assay Offices of Birmingham, Sheffield, and Chester.

Quantity of Standard Silver prepared at the Royal Mint in 1899.

	Ounces.
For Imperial Coinage (925 standard) ...	10,677,155
For Colonial Coinage (925 standard) ...	251,531
For Colonial Coinage (800 standard) ...	5,743,657
For War Medals (925 standard) ...	52,015
Total	16,724,358 or 512 Tons.

Assay Office Returns for 1899 (Mint Report).

	Ounces.
Silver marked at Birmingham	2,823,525
Silver marked at Sheffield	1,323,917
Silver marked at Chester	741,044
	4,888,486 or 149½ Tons.

No official returns are made of the weight of silver marked annually at the Assay Offices of London, Scotland, and Ireland, but the following figures are given by Redman‡ for 1898.

Quantity of Silver marked at other Assay Offices in 1898. (Redman.)

	Ounces.
London	2,103,652
Edinburgh	15,413
Glasgow	15,321
Dublin	8,123
Total	2,142,509

This latter quantity added to that marked at the Assay Offices quoted above gives a total of 7,030,995 ounces (215 tons) of silver used for industrial purposes.

It may be remarked that the weight of foreign silver wares which are imported and marked in this country is included in this total, but the amount is comparatively small.

After making allowance for the quantity of standard silver used annually for the manufacture of small articles which are exempt from Hall marking, a total of twenty-two and a half million ounces or about 689 tons would probably be a fair approximation to the total quantity of standard silver prepared annually in the United Kingdom.

‡ "Hall Marks," Redman, 1900 Edit., p. 131.

By an Act of Parliament passed in 1867 (30 and 31 Victoria, c. 90, s. 1), annual licences must be taken out by every dealer in silver articles in respect of any shop, and by every hawker or pedlar, a penalty of £50 being imposed for dealing without licence. For silver wares above 5 dwts. and under 30 ozs. in one article the licence is £2 6s. 0d., above 30 ozs. £5 15s. 0d.

In order to prevent the manufacture of spurious plate, the law requires that the quality of the metal of all silver wares, with certain exceptions, shall be determined by assay at offices duly authorised for that purpose in various parts of the Kingdom, and that if it be found equal to standard it shall be stamped at those offices with a series of marks, but that if the wares are found to be below standard they shall be broken up and the silver returned to the owner, who is to be charged a penalty of 6d. per ounce.

The marks employed denote the quality of the standard, the place of assay, and the year; the law also requires that all wares sent to be assayed must bear the maker's mark. The name of the maker is indicated by his initials; the standard of 11 ozs. 2 dwts. (925) by a lion passant; and that of 11 ozs. 10 dwts. (959) by a lion's head erased (*i.e.*, without the body) and the figure of Britannia, except at Birmingham and Sheffield, where Britannia alone is used; the place of assay is indicated by heraldic arms, and the year of assay by a letter, which is used throughout the year and is changed every year.

Duty was formerly charged on all silver wares, the payment of duty being indicated by the sovereign's head, but this has been omitted since 1890 when the duty was abolished.

At the present time there are four Assay Offices in England, for which the arms are as follows:—

Birmingham ...	An anchor.
Chester	A sword between three garbs.
London	A leopard's head (the arm of the Goldsmiths' Company).
Sheffield ...	A crown.

Formerly there were nine Assay Offices, but those at York, Exeter, Bristol, Norwich, and Newcastle-on-Tyne have been closed, probably on account of the trade being transferred to other centres such as Birmingham, Coventry, Sheffield, and London.

There are two Assay Offices in Scotland, one in Edinburgh, and one in Glasgow, where a series of marks corresponding to the English is used, but the standard 925 is indicated by the thistle, with the addition of Britannia in the case of the standard of 11 ozs. 10 dwts.

The arms of the Scotch Assay Offices are:—

Edinburgh ...	A castle with three towers.
Glasgow ...	A tree growing out of a mount, with a fish and bell.

The office at Glasgow has not adopted the marks prescribed by the above statute, but uses the lion rampant instead of the thistle to denote the standard.

In Ireland the assaying and marking of silver plate is restricted to Dublin, where a series of marks corresponding to the English is also used. The place of assay is indicated by a figure of Hibernia, and the standard, which is 11 ozs. 2 dwts., by a harp crowned. No silver wares of the "new standard," 11 ozs. 10 dwts., are marked in Ireland.

There are no doubt some objections, as Chaffers remarks,§ to the principle of compulsory assaying and marking of gold and silver wares. In this country, however, the system has existed substantially in its present form since the reign of Edward I. Without speculating on its origin, and while making due allowances for its defects, it is established that it has resulted in the creation and maintenance of a high standard of excellence for all British assayed wares, which has not only raised the reputation of British workmanship at home and abroad, but has also created a large amount of private wealth readily convertible into money by reason of the guarantee of value which the Hall-marks afford.

Condueted by M. I. Cross.

REICHERT'S FINE ADJUSTMENT (*continued*). — Since the appearance of the June number, Reichert has written stating that for each turn of the milled head controlling his new lever form of fine adjustment, a movement of ·01 m/m is produced; in his ordinary system of direct-acting screw, the rate of movement per revolution of the milled head is ·3 m/m.

It will be seen that the rate of movement is three times as slow with the new fine adjustment. The new arrangement also permits of the use of coarse screws, which are obviously not so liable to wear as fine ones, and the whole of the mechanism is of steel.

The entire construction is undoubtedly thoroughly sound

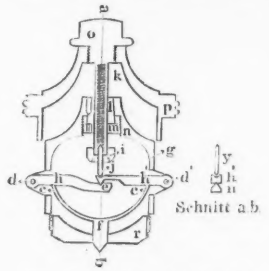


FIG. 1.—Sectional view. h, h', lever arms; j, point of contact with levers controlled by screw a; b, point which communicates the movement from levers through semi-circular connection e, f.

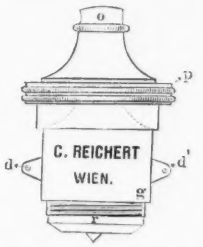


FIG. 2. — External appearance. h, h, fulcrum of lever arms.

mechanically, yet very simple in design, and exceedingly efficient practically. It is a distinct improvement to the Continental stand.

ZEISS'S FINE ADJUSTMENT.—This is fitted to a new stand for photo-micrography and projection only, and in actual working is exceedingly steady, sensitive, and soft to the touch.

The stand to which it is applied is arranged for use with Zeiss's new Planar lenses, which work without eye-pieces, and are intended for photographing large objects, there being sufficient room on the stage for an object 150 m/m in diameter; and, on the other hand, it is designed to work for projection or photography with objectives of the highest aperture and power.

It is extremely gratifying to find that a firm occupying the position that the house of Zeiss does in the optical world should have devised an improvement in such an important part as the fine adjustment.

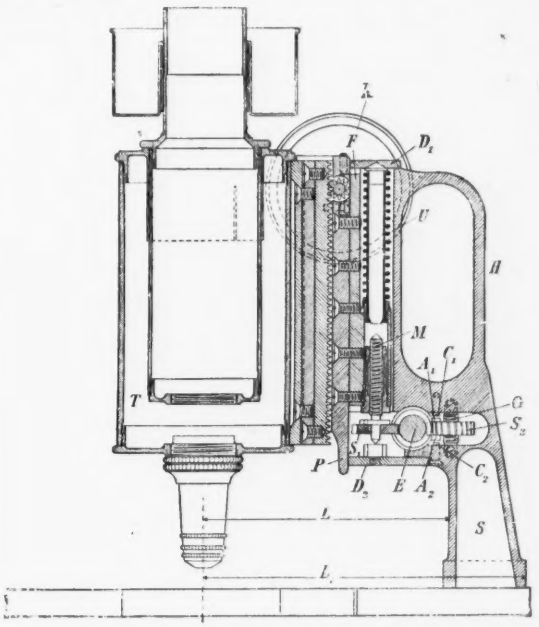


FIG. 3.—Sectional Views of Zeiss's Improved Fine Adjustment.

The slowest fine adjustment they made previously gave for each turn of the milled head ·25 m/m; in this new one a movement is produced of ·04 m/m for each revolution of the milled head, that is, it is six times as slow as the ordinary pattern. This in itself is an immense advantage.

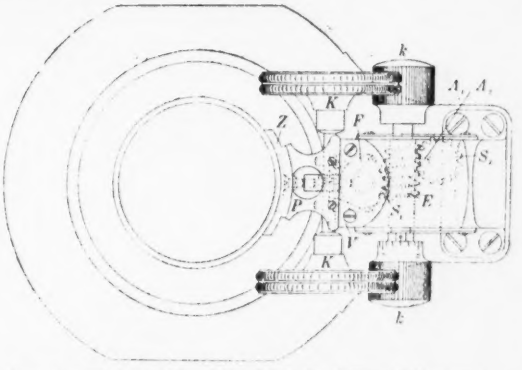


FIG. 4.—K, Controlling Milled Heads of Fine Adjustment. (For description see text.)

It will be noted that the two controlling screw heads are parallel, and instead of being placed at the top of the limb, as is usual in Continental models, are set on either side of the limb of the instrument. They are small in diameter, so that when low powers are used they can be revolved rapidly between the fingers.

The drawings are self-explanatory. It will be seen that the movement is affected by a cog-wheel system. The endless screw E operates the cog-wheel S_1, causing the long screw M to rotate, the reactionary effect being produced by the spiral spring U.

To prevent the over-turning of the screws, a cog, S_2, is provided, and this travels up and down on the pin G; stops are fitted A_1 and A_2, which come in contact with C_1 and C_2 when

§ Chaffers. "Hall Marks on Plate," 8th Edit., 1896, p. 43.

the fine adjustment is carried to its limit, and thus undue strain is prevented.

The construction presents features of originality and ingenuity. Every care has been taken to obviate unequal pressure, and consequent deterioration, and the whole mechanism is built in an extremely solid and workmanlike fashion.

STRINGER'S FINE ADJUSTMENT (made by W. Watson & Sons).—This is, to some extent, an amplification of Watson's Standard pattern.

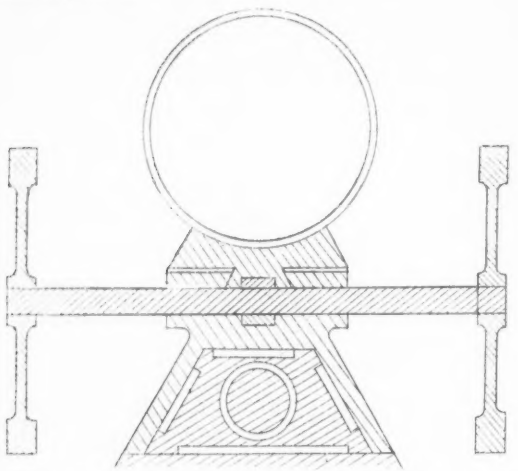


FIG. 5.—Stringer's Fine Adjustment, showing sectional view of triangular fitting bar, points of contact, body tube, coarse adjustment milled heads, &c.

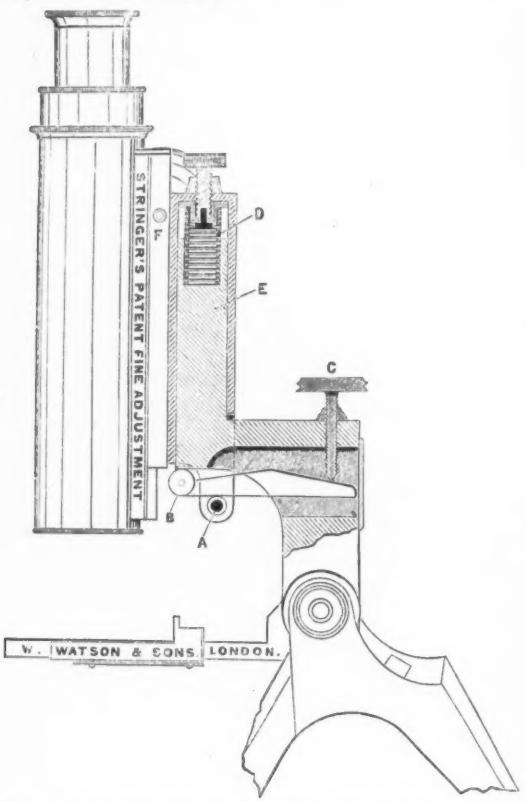


FIG. 6.—Sectional View of Stringer's Patent Fine Adjustment.

An examination of the drawings showing the cross section of this fine adjustment will at once reveal that it is made in a very substantial manner. The bar E, which is cast in one piece with the limb, is triangular in shape, and fitting exactly round it is a sleeve in which are grooved the dovetails that receive the body of the microscope.

The movement is effected by a lever of the second order, which operates by pressure upon a steel revolving pin A. This pin is mounted between two arms that are continued downwards, and are part of the sleeve fittings of the fine adjustment, the fulcrum being at B.

It will be seen that, contrary to the usual custom, the body is drawn downwards by the lever, and upwards by the spring D. A screw is provided for regulating the tension of this reactionary spring according to the angle at which the microscope may be inclined. Due provision is made for adjustment for wear, the frictional points of the bar E being very small, as shown in the cross section drawing, and the large back plate having adjustment screws so that the fitting may be altered as required.

The rate of movement of a fine adjustment of this description would necessarily vary with the size of the limb of the microscope, but the average rate of movement per turn of the milled head is ·05 m/m.

The special virtues claimed for this fine adjustment are extraordinary strength of construction, enabling it to stand rough treatment, and extreme sensitiveness. There is every indication that these claims are fully justified.

NOTES AND QUERIES.

J. F. A.—I have heard it stated that the blood of an habitual drunkard is different in appearance microscopically to normal blood. Can you tell me if this is correct, and if so, in what way it differs?

If any reader can obtain a drop of blood from such a subject and spread it on a microscope slip or cover glass, this question could no doubt be settled, but I am not aware of the existence of a difference.

T. H. M.—Of the microscopes you name, the D.P.H. No. 1 by Baker is unquestionably to be preferred. It is well designed and soundly constructed.

S. P.—Light filters are a necessity for photo-micrography of coloured objects. You cannot get satisfactory contrast without them. Of solutions, acetate of copper or Gifford's screen are the best, but opticians sell coloured glasses which usually serve the purpose. If these are used close to the lamp flame, they should be optically worked, any defect in the glass being present in the field of view when the condenser is focussed. If the coloured glass be placed immediately beneath the condenser, the optical working is not a necessity. The latter position is equally as good as the former.

Communications and enquiries on Microscopical matters are cordially invited, and should be addressed to M. I. CROSS, KNOWLEDGE *Office, 326, High Holborn, W.C.*

NOTES ON COMETS AND METEORS.

By W. F. DENNING, F.R.A.S.

COMET A 1901.—A considerable number of observations of this object have been published in the *Astronomische Nachrichten* and other journals. The proximity of the comet to the sun must have rendered it difficult to determine positions accurately, but there is little doubt that the orbit will be satisfactorily obtained. The comet was observed at various stations in South Africa and Australia, it was also seen at Trinidad and at Mount Hamilton, California. But the conditions of its appearance were such that it came under notice at very few northern observatories. In fact, after perihelion its orbit could scarcely have been more unfavourably placed with reference to observers in the northern hemisphere of the earth. The comet approached us from the region west of the sun, and could only have been visible in the morning hours, then moving eastwards and curving round the sun at a distance of about 15 degrees south of that luminary, it went off almost in a direct line into space just before it had got sufficiently far east of the sun to be well observed in the evening sky. But for the brilliancy of the comet and the conspicuous character of its tail it would no doubt have entirely escaped observation. That pretty large objects of this kind occasionally pass unseen is perfectly certain, for a bright comet was situated close to the sun during a total eclipse on May 17, 1882, and only one view was obtained of it. The recent

comet gave rise to many conflicting statements, but the hope was encouraged that it would present a fine appearance in the evening sky during May. Many people were disappointed in failing to catch a glimpse of it, but it may be some consolation to them to know that a naked-eye comet becomes visible nearly every year, and that they will probably not have long to wait before viewing one of these wonderful and mysterious visitors.

DISTRIBUTION OF COMETARY PERIHELIA.—With regard to the comets of short period, belonging to the Jovian family, of which there are now about 32 known with more or less certainty and probably quite distinct bodies (though less than half of them have been observed at more than one return), it is remarkable that the longitude of perihelion falls between 300°–360° and 0°–60° in 20 cases, whereas it is found between 60°–300° in only 12 cases. In other words, while 120° of longitude claim 20 comets, 240° claim only 12. Were the distribution perfectly equable the proportionate numbers instead of being 20 to 12 would be 10·7 to 21·3. The dense grouping therefore between 300°–360° and 0°–60° is significant that some special cause has operated in arranging these cometary perihelia on one and the same side of the sun. In this connection it is also interesting to note that the number of meteors encountered by the earth in passing from longitude 270°–360° and 0°–90° is about double that met with in moving from 90°–270°, and a partial explanation may be found in the special accumulation of cometary paths on that side of the sun near the first point of Aries where the earth would be likely to pick up more fragments than on the opposite side in a region traversed by comparatively few comets. This grouping does not, however, appear to be true of parabolic comets, according to some deductions by Chambers in his *Descriptive Astronomy*, but the subject is of sufficient importance to be investigated on the basis of all the materials obtained up to the present time. Though only 32 Jovian comets (including the certain and doubtful instances) are known, it is likely that any peculiarity affecting the distribution of these also affects the whole class, which probably numbers some hundreds at least, for in spite of the perseverance and success of comet seekers during the past century, it is certain that a great many short period comets have managed to evade discovery.

LARGE METEORS.—In the spring and early summer seasons there is little to offer special attractions to meteoric observers apart from the April Lyrids and May Aquarids. But there are a considerable number of minor showers visible in various parts of the firmament, and brilliant fireballs are occasionally recorded. A few bright meteors were observed in May, 1901, and the following are some particulars:—

May 11, 14h. 2m. Equal to Sirius. Passed from one-third the distance from ξ to ζ Draconis to η Cephei. Prof. A. S. Herschel, Slough.

May 11, 14h. 27½m. Equal to Vega. Path, 270° – 10° to 285°–10°. Duration 3 seconds. W. H. Mordoch, Glasgow.

May 14, 11h. 3m. Equal to Vega. Path, 125+30 to 148+12. Duration 7 seconds. Prof. Herschel, Slough.

May 15, 9h. 3m. Very large, and estimated ten times more brilliant than Venus. Fell from altitude 60° due N. to 30° N.W. D. R. Springall, Norwich.

May 15, 10h. 0m. Brilliant meteor of a green hue, and leaving a tail of red sparks, passed vertically down S. by W. sky, near horizon. Miss L. M. Milner, Torquay.

May 16, between 11h. and 11h. 15m. Large meteor about twice the size of Mars passed from near α Herculis through northern part of Cepheus and disappeared just under the Polar Star. It moved very slowly. W. H. Venables, Tripoli, Barbary.

May 17, 12h. 25m. Brighter than Jupiter. Travelled from the head of Serpens to N.W., ending between α and η Boötis. Dr. F. Noble, Radfield-by-Sittingbourne.

JULY METEORS.—With July we have the advent of the most interesting part of the meteoric season. After the middle of the month shooting stars become numerous, and towards the end there are many Aquarids and Perseids. This year observations will be best made in the comparative absence of moonlight between the 10th and 27th, though even at the close of the month and early in August there will be plenty of meteors to record in spite of the presence of our satellite. It will be important to watch for the earliest manifestation of the Perseids at about the middle of July, and to determine the position of the radiant on any and every night when a sufficient number of paths have been registered to indicate it satisfactorily.

THE FACE OF THE SKY FOR JULY.

By A. FOWLER, F.R.A.S.

THE SUN.—On the 1st the sun rises at 3.48, and sets at 8.18; on the 31st he rises at 4.23, and sets at 7.49. He is at his greatest distance from the earth on the 4th at 5 P.M., his apparent diameter then reaching its minimum value of 31′ 30″·7. The appearance of a large spot during the latter half of May suggests that the sun has entered on a new period of spot activity.

THE MOON.—The moon will be full on the 1st at 11.18 P.M., will enter last quarter on the 9th at 3.20 A.M., will be new on the 15th at 10.11 P.M., will enter first quarter on the 23rd at 1.58 P.M., and will be again full on the 31st at 10.34 A.M. The following are among the occultations visible at Greenwich during the month:—

Date.	Name.	Magnitude.	Disappearance.	Angle from North.	Angle from Vertex.	Reappearance.	Angle from North.	Angle from Vertex.	Moon's Age.
				°	°		°	°	d. h.
July 2	B.A.C. 6710	6·0	9.29 P.M.	157	186	9.47	184	212	16 8
,, 3	B.A.C. 7063	6·2	9.59 P.M.	151	182	10.17	181	210	17 9
,, 28	21 Sagittarii	4·9	9.51 P.M.	60	61	11.6	282	271	13 0
,, 29	δ Sagittarii	4·9	8.33 P.M.	96	116	9.48	243	252	13 23

THE PLANETS.—Mercury will be an evening star until the 13th, when he will be in inferior conjunction with the sun, and will be a morning star during the remainder of the month.

Venus is an evening star, but sets about an hour after the sun throughout the month. On the 15th the illuminated part of the disc is 0.936.

Mars is now of little interest to the observer, and can only be observed for a short time after sunset. On the 1st he sets about 11.17 P.M., and on the 31st about 9.45 P.M., his apparent diameter dwindling from 6″·2 to 5″·4. The planet moves in an easterly path a little south of the stars β, η, and γ Virginis.

Jupiter is fairly well placed for observation, though the low altitude places the planet at a disadvantage for observers in our latitudes. His path is retrograde, or westerly, in Sagittarius. On the 1st the meridian passage is at 11.58 P.M., and on the 31st at 9.45 P.M., the apparent diameter diminishing from 43″·4 to 42″·2. The following table indicates the more interesting satellite phenomena at convenient hours:—

		H.	M.	S.
1st.—	I. Oc. R. ...	9	41	0
3rd.—	III. Tr. I. ...	11	2	0
	III. Sh. I. ...	11	22	0
4th.—	II. Tr. I. ...	9	22	0
	II. Sh. I. ...	9	35	0
	II. Tr. E. ...	12	10	0
	II. Sh. E. ...	12	23	0
7th.—	I. Tr. I. ...	11	48	0
	I. Sh. I. ...	11	59	0
8th.—	I. Oc. D. ...	9	7	0
	I. Ec. R. ...	11	34	24
11th.—	II. Tr. I. ...	11	37	0
	II. Sh. I. ...	12	10	0
15th.—	I. Oc. D. ...	10	51	0
16th.—	I. Sh. I. ...	8	22	0
	I. Tr. E. ...	10	15	0
	I. Sh. E. ...	10	39	0
20th.—	II. Ec. R. ...	11	43	24
23rd.—	I. Tr. I. ,,,	9	43	0
	IV. Oc. R. ...	9	44	0
	I. Sh. I. ...	10	17	0
	I. Tr. E. ...	12	1	0
	I. Sh. E. ...	12	34	0
	IV. Ec. D. ...	12	37	52
24th.—	I. Ec. R. ...	9	52	16
27th.—	II. Oc. D. ...	10	15	0
28th.—	III. Oc. D. ...	10	52	0
29th.—	II. Tr. E. ...	8	6	0
	II. Sh. E. ...	9	29	0
30th.—	I. Tr. I. ...	11	29	0
	I. Sh. I. ...	12	11	0
31st.—	I. Oc. D. ...	8	48	0
	I. Ec. R. ...	11	47	0

Saturn, a little to the east of Jupiter, is in opposition on the 5th, being on the meridian at 12.20 A.M. on the 1st, and at 10.14 P.M. on the 31st. On the 24th, the apparent polar diameter of the planet is 17″, and the major and minor axes of the outer ring 42″·4 and 18″·1 respectively, the northern side being turned towards the earth.

Uranus is fairly well placed for observation, nearly midway between η Ophiuchi and Antares, crossing the meridian at 10.13 P.M. on the 1st and at 8.12 P.M. on the 31st.

Neptune is too near the sun for observation.

XUM

THE STARS.—About 10 P.M., at the middle of the month, Perseus, Andromeda, and Cassiopeia will be in the north-east; Cygnus and Pegasus in the east; Aquila in the south-east; Lyra nearly overhead; Corona, Libra, and Virgo in the south-west; and Ursa Major in the north-west.

Observers desirous of following the variations of Nova Persei will find an excellent guide to its position in the photographs by Mr. Stanley Williams, which appear elsewhere in the present number.

There will be a minimum of Algol at 10.34 on the 17th.

Chess Column.

By C. D. LOCOCK, B.A.

Communications for this column should be addressed to C. D. LOCOCK, Netherfield, Camberley, and be posted by the 10th of each month.

Solutions of June Problems.

No. 1.

(Mrs. W. J. Baird.)

1. B to B6, and mates next move.

No. 2.

(D. L. Anderson.)

Key-move.—1. P × B, becoming a Bishop.

If 1. . . P to R8 (becoming a Knight), 2. B to R3, etc.
1. . . P Queens, 2. Kt to K7, etc.

[This problem has been kept in reserve for some months with the intention of letting it act as a "separator" at the end of the first half of the tourney. It has fulfilled its function admirably, the result being considerable gaps in the score. Apart from the "trickiness" of the actual key, the problem is noteworthy on account of the beautiful "try" by 1. P to B7, met only by B to Q3, and if then 2. BP queens, B to B2. 1. P × B, becoming a Queen, is answered by P to R8, becoming a Knight, and stalemate will result.]

A. E. Whitehouse.—In No. 1. B × R is answered by B to R3, or P to B5.

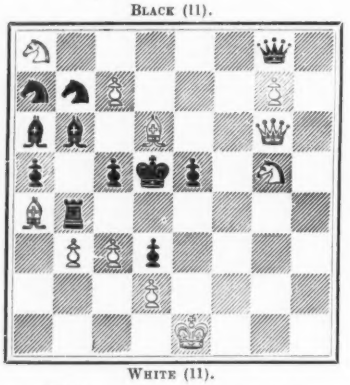
H. Le Jeune and *Alpha.*—You will see that your corrections as to No. 2 have been noted.

PROBLEMS.

No. 1.

By A. H. Williams.

BLACK (11).



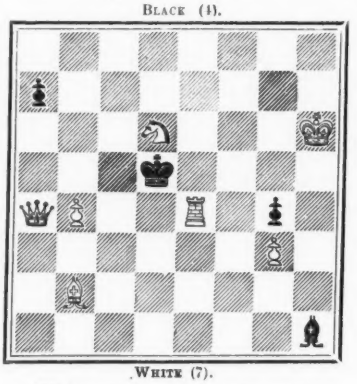
WHITE (11).

White mates in two moves.

No. 2.

By B. G. Laws.

BLACK (9).



WHITE (7).

White mates in three moves.

The following is the present score in the Solution Tourney:—

Thirty-two points.—S. G. Luckcock, C. Johnston, J. T. Blakemore, A. C. Challenger, W. Jay.

Thirty-one points.—J. Baddeley, G. Groom, W. H. S. M., F. Dennis, G. W. Middleton, H. Le Jeune.

Twenty-nine points.—G. W., Alpha.

Twenty-eight points.—V. H. Macmeikan, F. J. Lea, W. de P. Crousaz, C. C. Massey, Eugene Henry, A. J. Head, W. Nash, J. Sowden, E. Hunt, J. E. Broadbent, C. Child.

Twenty-six-points.—G. A. Forde (Capt.), A. H. Machell Cox, H. Boyes, C. F. P.

Twenty-five-points.—Endirby, C. C. Pennington.

CHESS INTELLIGENCE.

A match between Scotland and the North of England, with 25 players aside, resulted on May 25th in a decisive victory for the Scottish team, the score being 13 to 6, with six games left over for adjudication. The match was played at Glasgow, so that the winning side were naturally well represented, the losers being considerably handicapped by the railway journey and the absence of Mr. Burn and many other of their leading players. A return match will probably take place at Manchester next May.

Essex have created a surprise by defeating Surrey in the Southern Counties' Competition. The score was 8½ to 7½, the winning team being led by Mr. W. Ward and Dr. Smith, who defeated Mr. G. E. Wainwright and Mr. A. Curnock.

The Hastings Chess Club, certainly one of the strongest organizations in the South of England, has arranged a chess tour for next month. They will play matches with Wiltshire, Bath, Bristol, Cheltenham, South Wales, Cork, and the two leading Dublin clubs.

For Contents of the Two last Numbers of "Knowledge," see Advertisement pages.

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